File ACT/047/003

PARAHO DEVELOPMENT CORPORATION

FOR THE GOOD OF MANKIND

September 9, 1982

Mr. Wayne Hedberg
Division of Oil, Gas, and Mining
4241 State Office Building
Salt Lake City, UT 84114

Dear Mr. Hedberg:

Enclosed, per your request, is a copy of the Paraho-Ute Project Technical Report. This report provides additional, site-specific information concerning Paraho's project as described in the Uintah Basin Synfuels Development Draft Environmental Impact Statement.

Sincerely,

Bill Irwin

Bill Irwin

BI:oh

Enc.

cc: T.R. Log File

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DIVISION OF
OIL, GAS & MINING

PARAHO-UTE PROJECT
TECHNICAL REPORT

PARAHO DEVELOPMENT CORPORATION

PARAHO-UTE PROJECT TECHNICAL REPORT

Prepared by

Paraho Development Corporation

This report was prepared by Paraho Development Corporation, as requested by the Bureau of Land Management EIS Services (Denver, CO), as additional information for the Uintah Basin Synfuels Development Environmental Impact Statement.

June 1982

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THE PARAHO-UTE PROJECT TECHNICAL REPORT

1.0 INTRODUCTION

In accordance with the National Environmental Policy Act of 1969, the Bureau of Land Management (BLM) Utah State Office is preparing an environmental impact statement (EIS) covering proposed rights-of-way on public lands for synthetic fuel projects in the Uintah Basin located in eastern Utah (BLM 1981). The rights-of-way across public lands Paraho is considering for the Paraho-Ute Project include:

- Main access road to the plant site (permit application submitted May 28, 1981).
- Access road to on-site construction camp (permit application to be submitted later in 1982).
- Product oil pipeline spur (permit application submitted September 23, 1981).
- Alternate water pipeline (permit application to be submitted if needed).
- Electric power corridor (permit application being submitted by Moon Lake Electric).

The EIS contains a regional cumulative analysis and site specific analyses which address the individual projects such as the Paraho-Ute Shale Oil Facility. The BLM requested that Paraho Development Corporation (Paraho) prepare a technical report describing in detail the Paraho-Ute Shale Oil Facility as supplementary information to the EIS. This report, "THE PARAHO-UTE PROJECT TECHNICAL REPORT", has been prepared in accordance with the request of the BLM Environmental Impact Statement Services (Pizel 1982).

Section 1.0 provides the introduction and summary of this report and a discussion of the purpose, need, and objective of the Paraho-Ute Shale Oil Facility.

This report contains two major sections: Section 2.0, HIGH LEVEL SCENARIO, THE PARAHO-UTE PROJECT, and Section 3.0, LOW LEVEL SCENARIO, SINGLE RETORT OPERATION. The plant design, operating information, and other details presented in Section 2.0 constitute the high level scenario. Those discussed in Section 3.0 provide a production rate alternative, the low level scenario. As discussed in Subsection 4.1, Paraho proposes an alternative schedule, the Phased Schedule. The Phased Schedule is a combination of the high level and low level scenarios. The plant design, operation information, and other details of the Phased Schedule fall within the bounds established by the high and low level scenarios.

In addition to presenting details on the Phased Schedule, Section 4.0, OTHER PROJECT ALTERNATIVES, provides additional alternatives concerning other specific components of the proposed facility. The Appendix, Section 5.0, provides the baseline environmental data concerning air quality and meteorology that was requested by the BLM. The baseline data were obtained from a series of reports describing the White River Shale Project, Federal Prototype Leases Ua and Ub (VTN 1976; VTN 1977), and from the "Paraho Commercial Feasibility Study" (Paraho 1982).

1.1 Summary

Paraho plans to design, construct, and operate the Paraho-Ute Shale Oil Facility. This commercial facility will be located on a 1416-acre site situated on Section 32, Township 9 South, Range 25 East, SLM, and Sections 5, 6, and 7, Township 10 South, Range 25 East, SLM, Uintah County, Utah.

The Paraho retorting technology, to be used in the Paraho-Ute Shale Oil Facility, has been tested extensively. It has been used commercially for limestone calcination for more than ten years and has been used in oil shale research operations that produced over 100,000 barrels of shale oil.

The facility will be comprised of: an underground mine; shale preparation facilities; three Paraho retorts; retorted shale disposal and raw shale fines storage sites; oil upgrading (hydrotreating), storage and transportation facilities; gas clean-up and cogeneration of electrical power; auxiliaries; and off-site rights-of-way. When the Paraho-Ute Shale Oil Facility is operating at its design rate, the projected production (per stream day) will be: approximately 42,000 barrels of hydrotreated oil, 185 megawatts of electrical power, 210 tons of anhydrous ammonia, and 95 tons of elemental sulfur.

Details concerning the Paraho retorting technology have been published previously (Pforzheimer 1974; Jones 1976; Jones and

Heistand 1979). Most of the design detail and environmental information are obtained from the two programs: "Paraho Module Project" (Paraho 1981) and "Paraho Commercial Feasibility Study" (Paraho 1982). The information produced from these programs and used in this report is based upon preliminary engineering design used to establish cost estimates at the ± 25% level. Additional environmental information concerning the Paraho process was obtained from Paraho research operations conducted at Anvil Points near Rifle, Colorado (Heistand, et al 1980; Limbach and Heistand 1982).

1.2 Purpose, Objectives and Need

The purpose of the Paraho planned development is to help build the synthetic fuels industry in Utah and the United States. To accomplish that purpose, Paraho has set the specific objective of building and operating a commercial oil shale facility in Uintah County, Utah.

The need for the Paraho-Ute Shale Oil Facility is to serve as part of our nation-wide effort to reduce our dependence upon foreign oil and to improve both our defense posture and balance of trade position. In addition, building the synthetic fuels industry will improve the world's energy options by developing alternatives to conventional crude oil.

The Paraho-Ute Shale Oil Facility will produce approximately 42,000 barrels per stream day of hydrotreated shale oil. This hydrotreated shale oil will be shipped to refineries for conversion into distillate fuels, such as transportation fuels for domestic and defense uses. A by-product from the Paraho-Ute facility is the cogeneration of 185 megawatts of electrical power produced from the gas obtained from the operation of Paraho retorts. This will supply all power needs for the project and result in excess power for marketing. About 30 megawatts of this electrical power will be marketed in order to reduce the need for additional power plants fueled by fossil fuels, thus further reducing our dependence upon foreign oil.

The objectives that would be met during Paraho's planned development would be:

- Production of more than 42,000 barrels of hydrotreated shale oil per stream day as a premium feedstock for refining into distillate fuels for local markets and defense use.

- Demonstration that the Paraho retorting technology is technically sound, economically cost-efficient, and environmentally acceptable on a commercial scale and thereby providing the opportunity for development of the estimated 600 billion recoverable barrels of shale oil in the tri-state area of Colorado, Utah, and Wyoming as well as the other large oil shale deposits in the eastern U.S.

- Development of the Uinta Basin oil shale reserves in a manner to assure the most beneficial resource utilization possible. Paraho will maximize shale oil production while minimizing the utilization of such resources as water, natural gas, and electricity. In addition, manpower resources will be utilized in a manner that will develop skills and technical experience, while adding to the productivity of the local and regional economies.

References

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Pizel, R. E., Office of Special Projects (EIS Services) BLM. Letter to R. N. Heistand, Jan. 26, 1982.

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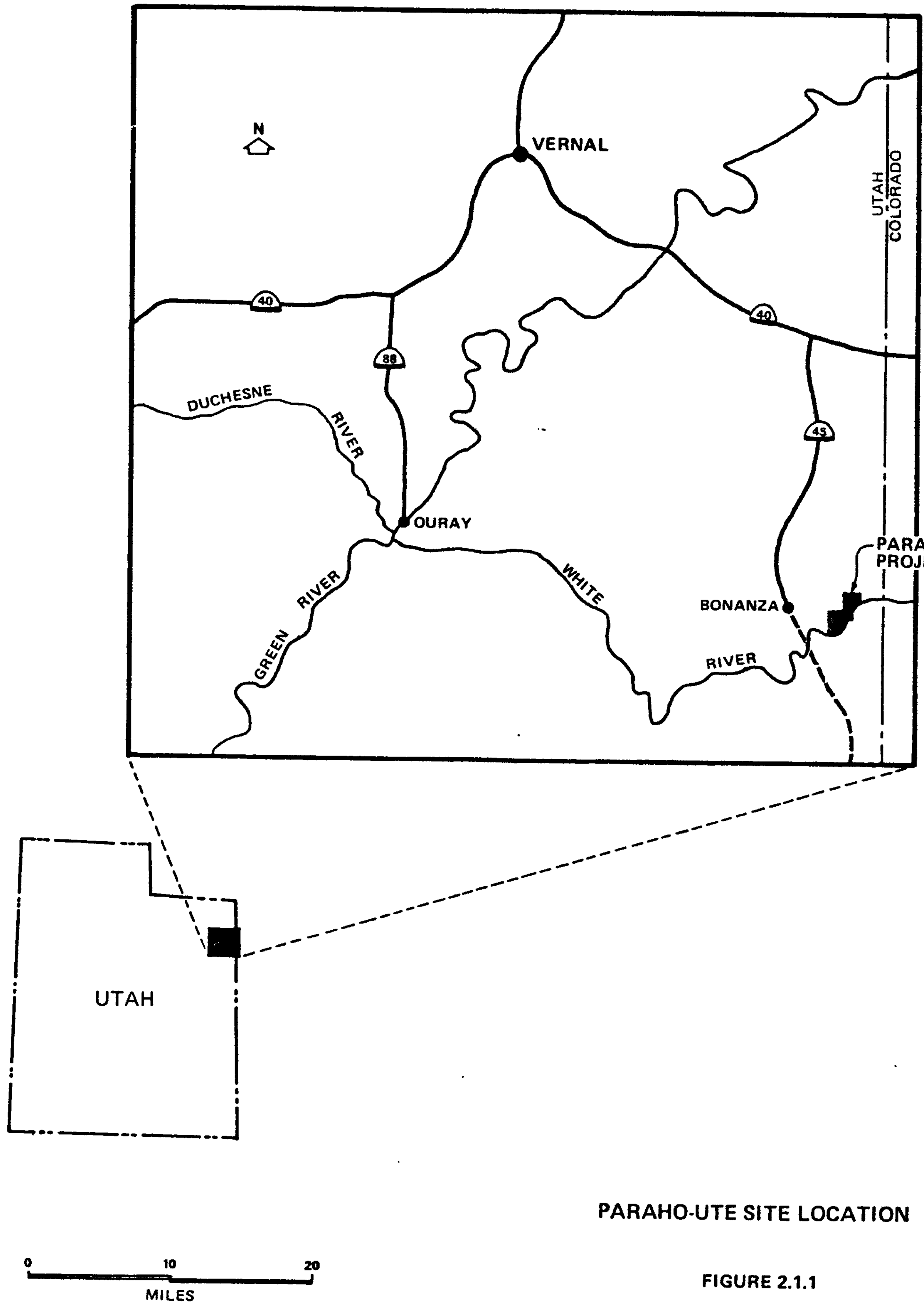
2.0 HIGH LEVEL SCENARIO -- PARAHO-UTE PROJECT

2.1 General Project Description

The site for the Paraho-Ute Shale Oil Facility is located in northeastern Utah, approximately 40 miles from Vernal, Utah. The tract presently consists of a 582-acre Utah State Mineral Lease (#35894, granted February, 1979), located in Section 32, Township 9 South, Range 25 East, SLM and an adjoining 834 acres owned by Skyline Oil Company and under lease to Sohio Shale Oil Co., located in Sections 5, 6, and 7, Township 10 South, Range 25 East, SLM. Sohio Shale Oil Co. will make this property available to Paraho for commercial development. Figure 2.1.1 shows the location of these two tracts and Figure 2.1.2 shows the close-up of the project site.

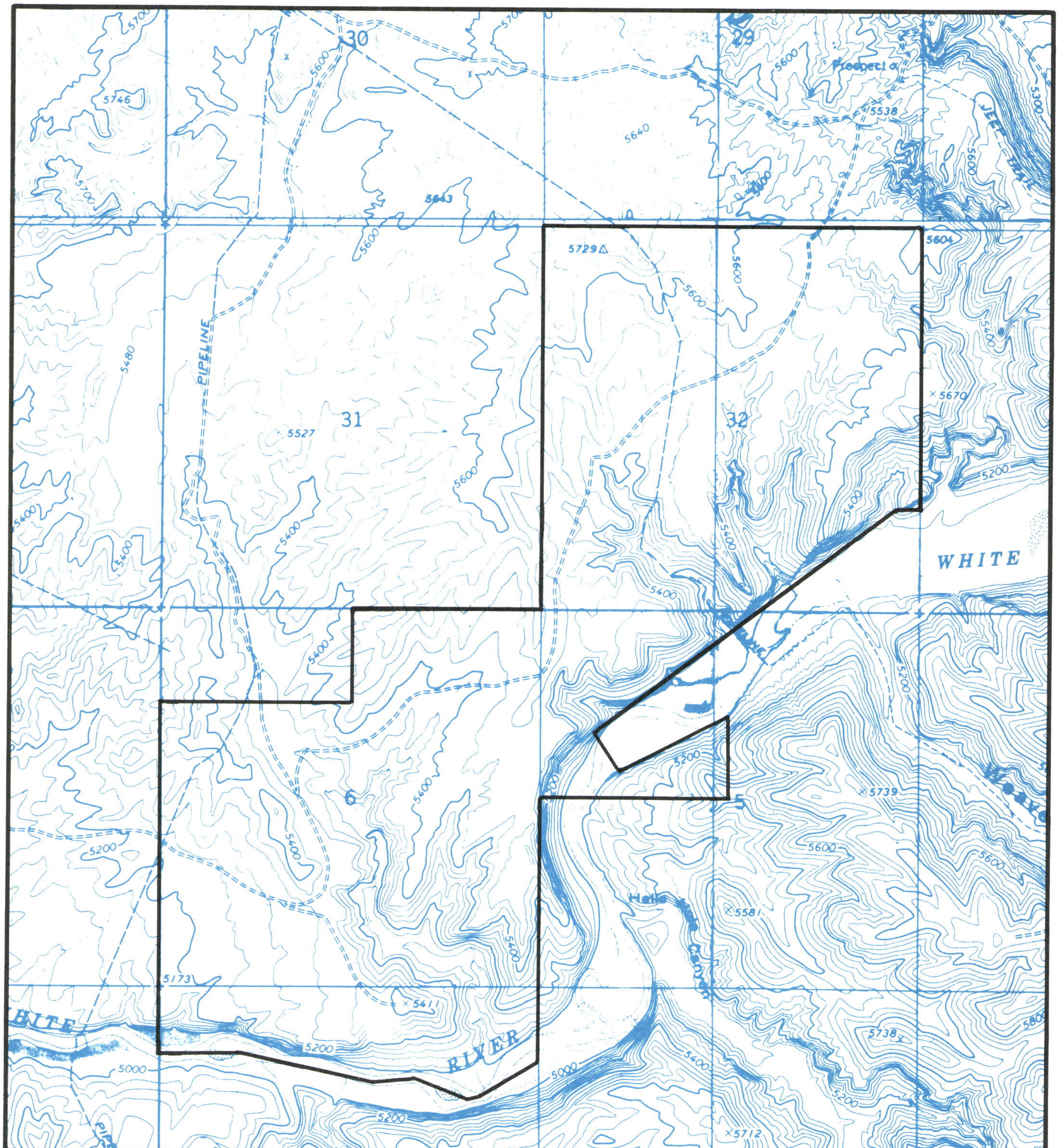
The topography of the area is characterized by generally flat plains, broken by occasional ridges and dissected by steep-sided streambeds. The project area itself is on a gently sloping plain that extends from the northwest to the project area where it is cut by the White River. The project area lies mainly between 5,400 and 5,700 feet elevation with the exception of the southern edge of the project site which drops from 5,400 feet to 5,000 feet along the steep bank of the White River.

The project description and analysis provided in this chapter discusses the construction on and development of these two tracts comprising a total of 1416 acres.



PARAHO-UTE SITE LOCATION

FIGURE 2.1.1



LEGEND

PROJECT BOUNDARY

PARAHO-UTE SITE CLOSE-UP

FIGURE 2.1.2

N

SCALE: 1" = 2000 FEET
Contour Interval 40 feet

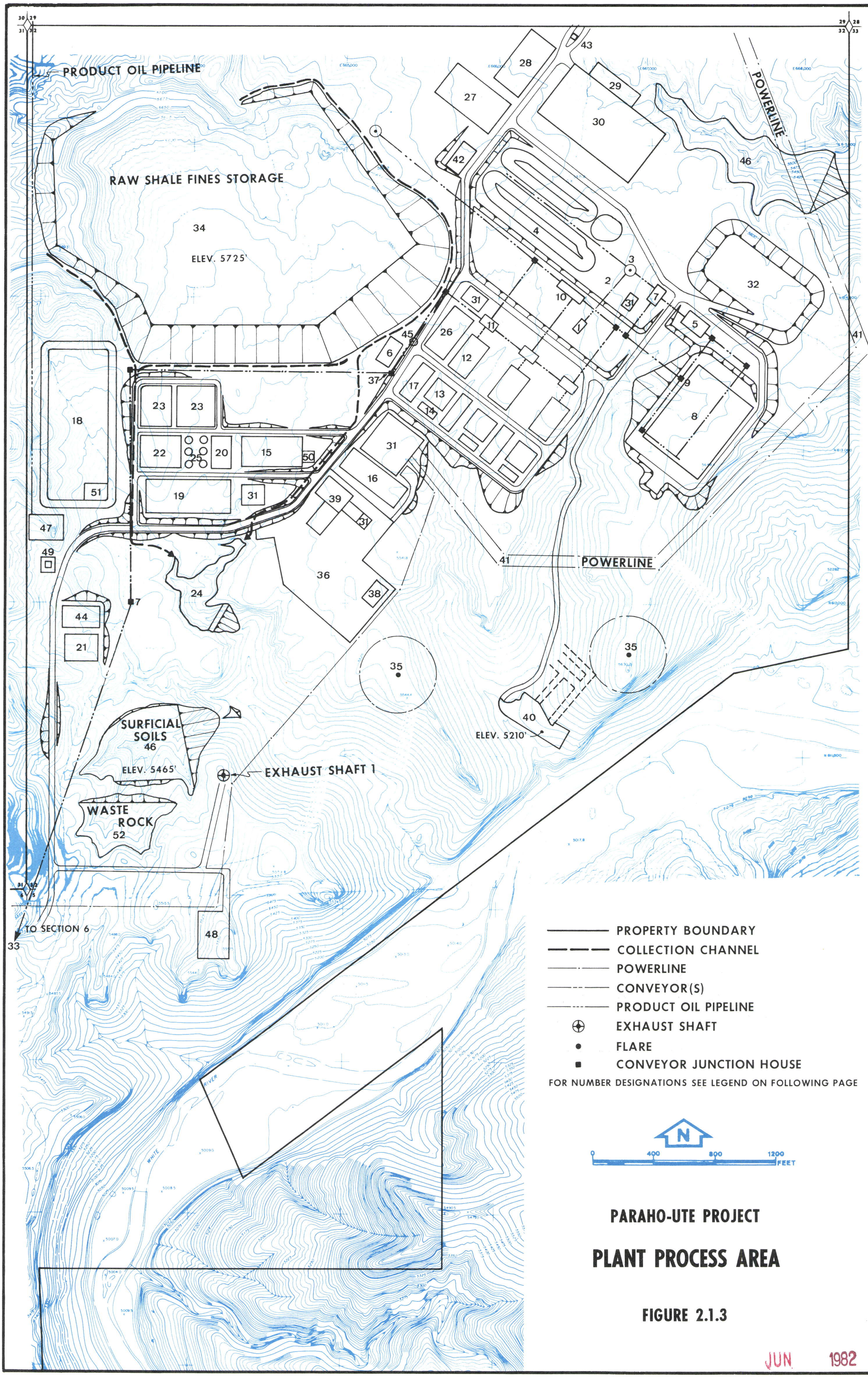
1982

Paraho is acquiring interests in supplemental tracts of land adjacent to or near the two tracts described above. An additional 600 acres have already been acquired by Paraho. Also, land exchanges and future acquisitions that would increase Paraho's total holding to slightly more than 4,600 acres are currently under negotiation. This total acreage will provide sufficient quantities of recoverable oil shale to maintain full operations at approximately 42,000 BPSD for more than 30 years

The Paraho-Ute facility will consist of an underground mine located in Sections 32 (T9S, R25E), 5, 6, and 7 (T10S, R25E), raw shale crushing and storage facilities, three Paraho retorts, oil separation units, gas treatment facilities, and facilities for shale oil upgrading, electrical power generation, product oil storage and transmission, and water treatment and containment. Additional facilities will be provided for retorted shale disposal and raw shale fines storage.

The plant process area, located on Section 32, is shown in detail in Figure 2.1.3. This area includes the retorts, hydrotreaters, mine surface facilities, oil storage tanks, wastewater treatment area, and associated facilities. The retorted shale disposal pile and its associated runoff diversion and containment structures are shown in Figure 2.1.4.

The facility will produce approximately 42,000 barrels per stream day (BPSD) of upgraded (hydrotreated) oil. The mine will produce,



PARAHO-UTE PROJECT

PLANT PROCESS AREA

FIGURE 2.1.3

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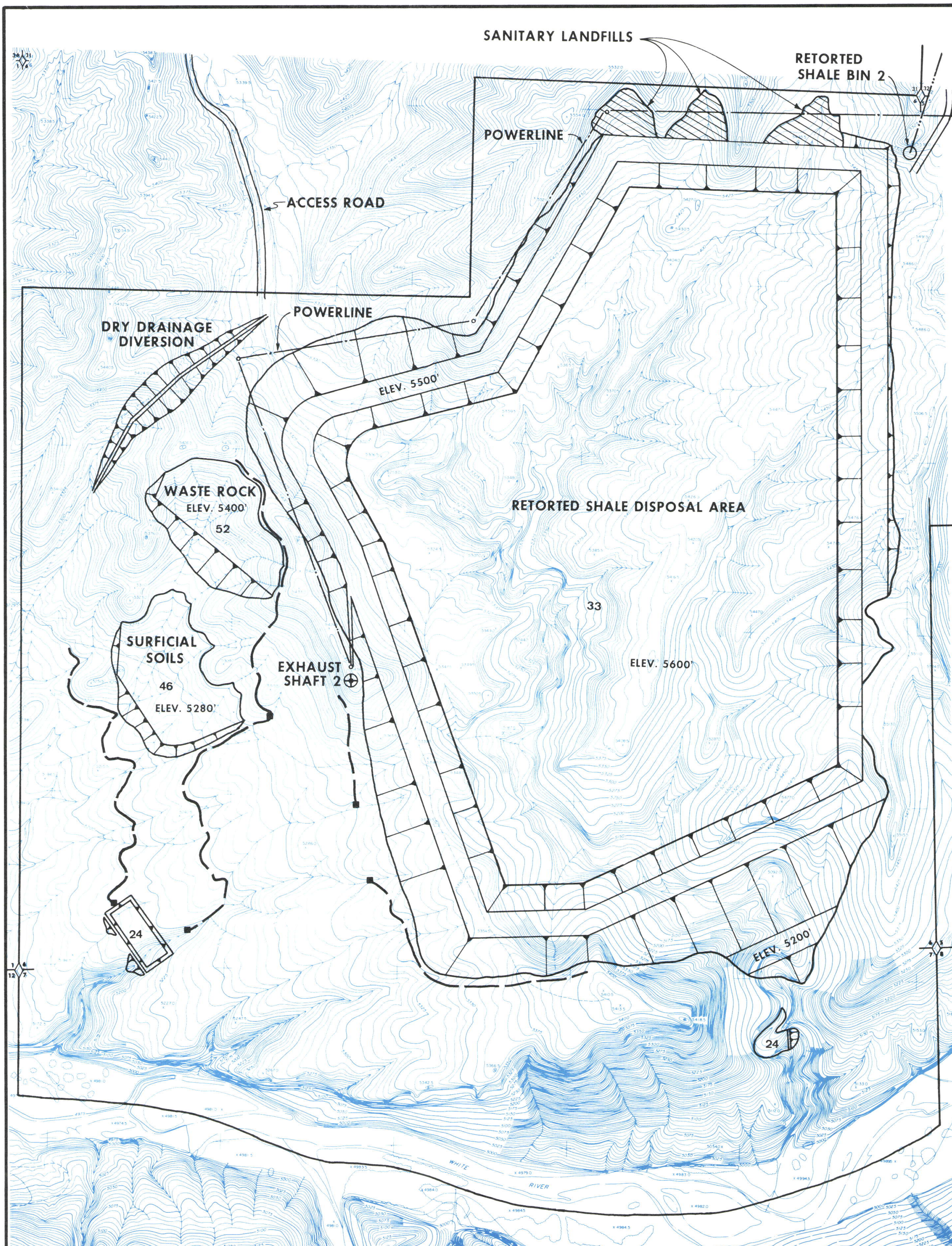


PROPERTY BOUNDARY
EXHAUST SHAFT
COLLECTION CHANNEL
POWERLINE

FOR NUMBER DESIGNATIONS SEE LEGEND ON FOLLOWING PAGE

N

0 400 800 1200 FEET

PARAHO-UTE PROJECT

RETORTED SHALE DISPOSAL AREA

FIGURE 2.1.4

JUN 1982

LEGEND

Supplement to Figures 2.1.3 and 2.1.4

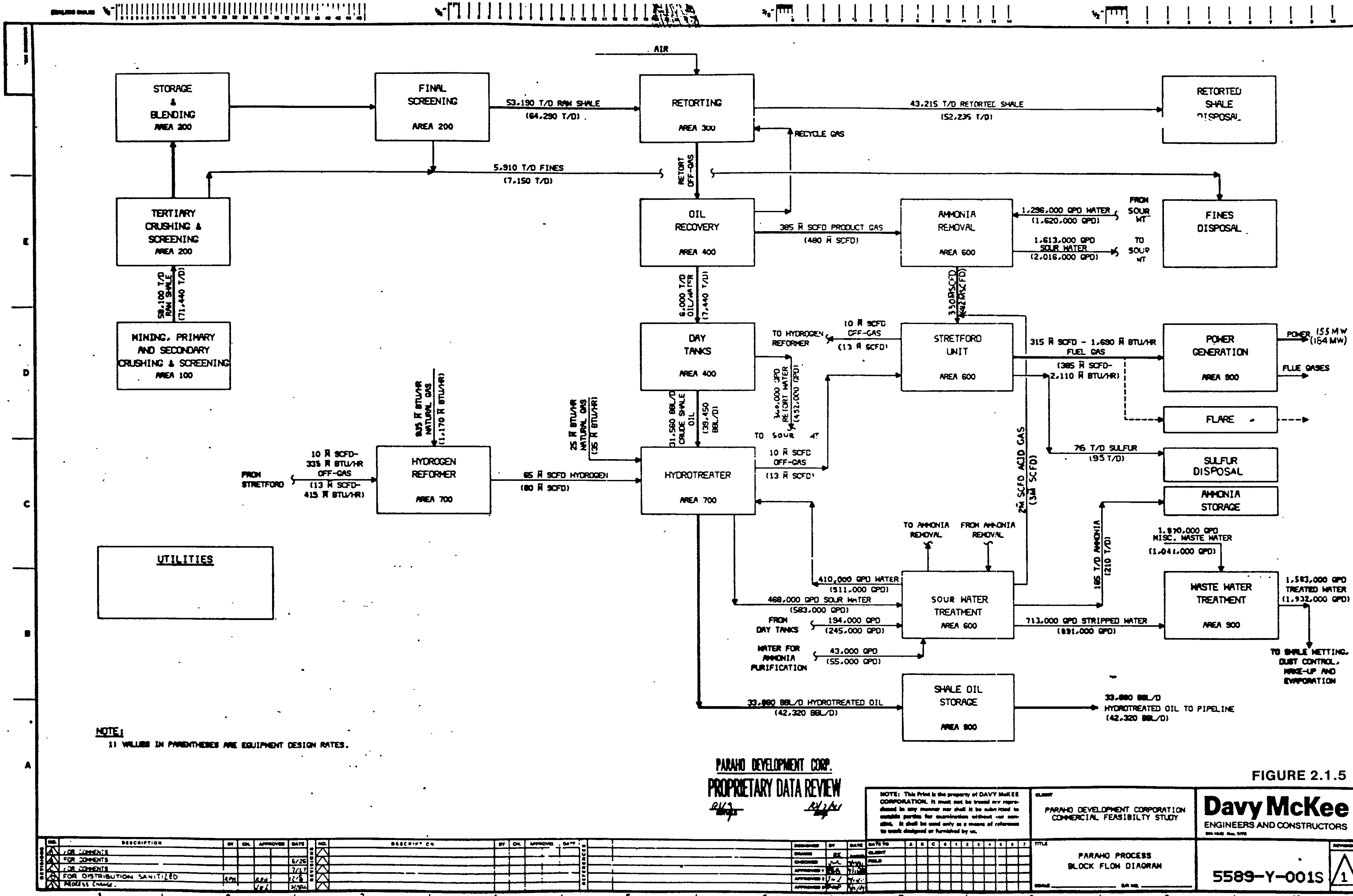
1. Mine Conveyor Drive House
2. Mine Conveyor
3. Mine Surge Bin
4. Emergency Raw Shale Storage
5. Crushing and Screening Station
6. Central Control Room and Lab
7. Conveyor Junction Houses
8. Prepared Shale Covered Storage
9. Distribution Bin
10. Screening Station
11. Sampling and Weighing Houses
12. Retorts
13. Oil Recovery
14. Compressor Houses
15. Gas Cleaning
16. Power Generation
17. Oil Coolers
18. Tank Farm
19. Hydrotreater
20. Sanitary Wastewater Treatment
21. Firewater Pond
22. Equalization Basin
23. Process Wastewater Treatment
24. Retention Pond
25. Thickener/Digester
26. Air Compressor, Plant Steam, and Inert Gas
27. Storage Yard
28. Receiving and Storage Room
29. Administration and Change House
30. Parking Area
31. Sub Stations
32. Temp. Raw Shale Storage (Mine Devel.)
33. Retorted Shale
34. Raw Shale Fines Storage
35. Flares
36. Mine Surface Facilities
37. Retorted Shale Disposal Conveyor
38. Fuel Oil Storage
39. Vertical Shaft (Main Access)
40. Mine Entrance and Vent Fans
41. Power Line
42. Maintenance Shops
43. Gatehouse
44. River Water Treatment
45. Retorted Shale Disposal Hopper
46. Surficial Soil Storage Area
47. Product Oil Pipeline Pumping Station
48. ANFO Mixing Plant and Magazine
49. Ammonia Storage
50. Sulfur Storage
51. Liquid Propane Receiving and Storage
52. Waste Rock Storage

on an average, about 71,440 tons per stream day (TPSD) of oil shale. These production rates reflect maximum design rates and are the basis for the rest of the discussion in the HIGH LEVEL SCENARIO.

The mine will be an underground room-and-pillar, top heading and bench system. Crushing and screening units are designed to provide approximately 65,000 TPSD of oil shale to the retorts. Raw shale fines will be stored on-site for probable future processing.

The plant has been sited and designed to minimize its visibility from outside the project area. The facilities on Section 32 (see Figure 2.1.3) are set within a topographic depression which is about 150-200 feet below the surface of the surrounding area. Such location also serves to minimize the potential visual impact of the tallest structures, the 155-foot retorts. Due to regional topographic features, it is not anticipated that the plant facilities will be visible from either the Bonanza-Rangely road or the White River. The facilities will be painted a grayish-brown or other appropriate color to blend with the surrounding environment, and traffic areas will be paved to minimize dust.

Figure 2.1.5 is a process flow diagram showing the overall movement of raw materials, products, and by-products through the Paraho-Ute facility. The values presented in parentheses are equipment design rates that are the basis for the technical description of the HIGH LEVEL SCENARIO. These values are the most current (Paraho 1982)


AIR
STORAGE & BLENDING AREA 200
FINAL SCREENING AREA 200
53,190 T/D RAW SHALE (64,290 T/D)
RETORTING AREA 300
43,215 T/D RETORTED SHALE (52,235 T/D)
RETORTED SHALE DISPOSAL
RECYCLE GAS
5,910 T/D FINES (7,150 T/D)
RETORT OFF-GAS
TERTIARY CRUSHING & SCREENING AREA 200
58,100 T/D RAW SHALE (71,440 T/D)
MINING, PRIMARY AND SECONDARY CRUSHING & SCREENING AREA 100
OIL RECOVERY AREA 400
385 M SCFD PRODUCT GAS (480 M SCFD)
AMMONIA REMOVAL AREA 600
1,296,000 GPD WATER (1,620,000 GPD)
FROM SOUR WT
1,613,000 GPD SOUR WATER (2,016,000 GPD)
TO SOUR WT
FINES DISPOSAL
6,000 T/D OIL/WATER (7,440 T/D)
330 M SCFD (412 M SCFD)
DAY TANKS AREA 400
TO HYDROGEN REFORMER
10 M SCFD OFF-GAS (13 M SCFD)
STRETFORD UNIT AREA 600
315 M SCFD - 1,690 M BTU/HR FUEL GAS (385 M SCFD-2,110 M BTU/HR)
POWER GENERATION AREA 900
POWER 155 MW (164 MW)
FLUE GASES
FLARE
362,000 GPD RETORT WATER (452,000 GPD)
TO SOUR WT
935 M BTU/HR NATURAL GAS (1,170 M BTU/HR)
25 M BTU/HR NATURAL GAS (35 M BTU/HR)
31,560 BBL/D CRUDE SHALE OIL (39,450 BBL/D)
FROM STRETFORD
10 M SCFD-335 M BTU/HR OFF-GAS (13 M SCFD-415 M BTU/HR)
HYDROGEN REFORMER AREA 700
65 M SCFD HYDROGEN (80 M SCFD)
HYDROTREATER AREA 700
10 M SCFD OFF-GAS (13 M SCFD)
24 M SCFD ACID GAS (30 M SCFD)
76 T/D SULFUR (95 T/D)
SULFUR DISPOSAL
AMMONIA STORAGE
UTILITIES
TO AMMONIA REMOVAL
FROM AMMONIA REMOVAL
410,000 GPD WATER (511,000 GPD)
468,000 GPD SOUR WATER (583,000 GPD)
FROM DAY TANKS
194,000 GPD (245,000 GPD)
WATER FOR AMMONIA PURIFICATION
43,000 GPD (55,000 GPD)
SOUR WATER TREATMENT AREA 600
165 T/D AMMONIA (210 T/D)
1,870,000 GPD MISC. WASTE WATER (1,041,000 GPD)
713,000 GPD STRIPPED WATER (891,000 GPD)
WASTE WATER TREATMENT AREA 900
1,583,000 GPD TREATED WATER (1,932,000 GPD)
TO SHALE WETTING, DUST CONTROL, MAKE-UP AND EVAPORATION
33,880 BBL/D HYDROTREATED OIL (42,320 BBL/D)
SHALE OIL STORAGE AREA 900
33,880 BBL/D HYDROTREATED OIL TO PIPELINE (42,320 BBL/D)
NOTE:
1) VALUES IN PARENTHESES ARE EQUIPMENT DESIGN RATES.
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PROPRIETARY DATA REVIEW
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PARAHO PROCESS BLOCK FLOW DIAGRAM
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PROCESS CHANGE

FIGURE 2.1.5

and may be refined and adjusted as the project is constructed. (The other values represent equipment production at base rates.)

The retorted shale disposal pile will be located on Section 6 (see Figure 2.1.4), about one mile southwest of the plant facilities and cover an area of about 340 acres. The outer slopes of the pile will be steep to resemble, as closely as possible, the natural, steep slopes of adjacent areas and to reduce the total surface area exposed to view. The disposal pile will be covered with stored topsoil and revegetated, and the steep sides will be faced with natural rock rip-rap to give the appearance of surrounding land surfaces.

2.2 Resource Requirements

This section discusses the various resource requirements of the Paraho-Ute Project. The construction and operation requirements are provided for each of the various resources. These resources include: land, oil shale reserves, water, manpower, electrical power, natural gas, other fuels, chemicals and catalysts.

2.2.1 Land Acreage Requirements and Status

Land requirements and status for the construction and operation phases of the project are listed in Table 2.2.1. The information provided in this table is based on specifications for right-of-way corridors (see Section 2.5.8) and plot plans (see Figures 2.1.3 and 2.1.4) for the surface facilities.

2.2.2 Oil Shale Reserves

The total in-place oil shale reserves from the mining zone in the Parachute Creek Member on the two Paraho tracts equals about 340 million tons. This oil shale zone averages 26-30 gallons of shale oil per ton of shale.

The recoverable oil shale on the Paraho tract equals approximately 200 million tons. The 140 million tons remaining as unrecoverable oil shale is accounted for in the support pillars and the boundary pillars surrounding the site.

TABLE 2.2.1

PARAHO-UTE LAND

REQUIREMENTS AND STATUS
(Estimates)

Component	Construction Acres	Operation Acres	Ownership
Off-Site Access Roads	127	51	BLM
Product Pipeline	42.5	42.5	BLM
Power Line	21.6	21.6	BLM/Utah
Water Line	32.4	32.4	Private
Mining Surface Facilities	23	15	Utah(1)
Shale Crushing and Handling	20	10	Utah(1)
Retorting and Oil Recovery Facilities	40	30	Utah(1)
Auxiliary Facilities	40	25	Utah(1)
Raw Water and Wastewater Treatment Facilities	30	20	Utah(1)
Other Storage (fuel, oil, explosives, bldg. material, etc.)	80	70	Utah(1)
Raw Shale Fines Storage	100	70	Utah(1)
Collection/Evaporation Ponds	20	15	Utah/(1) Skyline(2)
On-Site Paved Areas	110	45	Utah/(1) Skyline
Retorted Shale Disposal	370	340	Skyline
Construction Camp(3)	100	0	Skyline

(1) Utah State Mineral Lease No. 35894.

(2) Sohio Shale Oil Company has leased this land from Skyline Oil and will make it available to Paraho.

(3) Portion of the construction camp will be situated where the retorted shale disposal pile will ultimately be located. The construction camp will be decommissioned at the end of the construction period.

2.2.3 Water

The anticipated water requirements for construction and operation are listed in Table 2.2.2. Water produced during the retorting and off-gas clean-up (at a rate of about 1 cfs) will be available for other uses, such as dust control; therefore, the total raw water required for operations will be about 4 cfs.

Details of the off-site facilities and potential right-of-way corridors for the pipeline bringing water to the project site are provided in Section 2.5.8.

In accorance with a zero discharge concept, all wastewater at the project site will be recycled or evaporated. Under the normal, planned operations, there will be no wastewater discharged from the site.

2.2.4 Manpower

Construction. Paraho's projected employment schedule for construction begins during 1982 and lasts through 1987. Table 2.2.3 shows construction and operational employment figures for both the mining and plant facilities. Also included are the workers needed to operate the temporary construction camp. These numbers are the estimated average ranges for employment for six month periods. Maximum employment is expected in the latter half of 1985 with a gradual decline to normal operational employment in early 1987.

Paraho

TABLE 2.2.2
(Estimated)
PARAHO-UTE WATER REQUIREMENTS

WATER USES	Quantity GPM	Quantity AC-FT/YR
1. Construction (1)		
Mine Potable	10	16
Mine Non-Potable	99	159
Surface Potable	70	112
Surface Non-Potable	90	145
Construction Camp Potable	113	181
Construction Camp Non-Potable	7	11
Total Construction Use	389	624
2. Operation (2)		
Cooling Tower Evaporation	863	1,389
Processed Shale Disposal/Storage	725	1,167
Underground Mine	205	330
Belts and Dust Control	192	309
Process and Potable Uses	128	206
Retention Pond Evaporation	4	6
Wastewater Treatment Evaporation	7	11
Miscellaneous Evaporative Steam Losses	12	19
Sulfur Recovery	20	32
Total Operations	2,156	3,469
WATER SOURCES		
Gas Clean-up	218	351
Retort Product Water	168	270
Process Area Runoff	57	92
Raw Water Make-up (3)	1,713	2,756

(1) Water requirements are listed at maximum construction.

(2) Water requirements are listed at full design operation.

(3) Represents maximum raw water required, approximately 4 cfs.

Source: Paraho 1982.

TABLE 2.2.3
(Estimated)
PARAHO-UTE PERSONNEL REQUIREMENTS[1]

Year	Mining Construction	Mining Operation	Plant Construction	Plant Operation	Construction Camp[2]	Total
1982	0		0		0	0
	100		120		0	220
1983	220		450		100	770
	280		700		100	1080
1984	280		900		100	1280
	280		1200		100	1580
1985	150	175	1600	250	150	2325
	100	550	2000	350	150	3150
1986	80	550	1500	350	150	2630
	80	640	800	380	100	2000
1987	0	640	800	460	100	2000
	0	640	200	460	0	1300
1988-2000	0	640	0	460	0	1100
	0	640	0	460	0	1100

(1) Paraho 1982.

(2) Personnel required to service construction camp.

The figures given for the plant construction force include direct hire, construction management and engineers, and indirect manhours for construction. The estimated breakdown of the total construction personnel is given in Table 2.2.4. The various types of craftsmen will be added as needed throughout the construction period until the total number of required personnel is reached.

Operation. Many of the underground mining activities are similar during construction and operation, so the types of craftsmen required for mine construction and operations will be the same. As development progresses on the mine, additional workers will be hired to bring the mining activities into full production.

The estimated type and number of personnel needed for operation of the plant and mine is shown in Table 2.2.5. The estimates for operation of the plant are based on experience at Paraho's oil shale retorting facility at Anvil Points and subcontractor's experience in mining and oil refinery operations.

The local region (Uintah County and surrounding counties) will not be able to provide a large portion of the technical employment required for construction and operations. It is expected that 10 percent of the workforce will be local workers and 90 percent will be non-local personnel. Paraho will attempt to maximize the use of local workers in line with past company practices. In an effort to mitigate socioeconomic impact caused by large scale importation of workers to the plant site, Paraho will, whenever possible, utilize and upgrade local workforce skills.

TABLE 2.2.4

TOTAL CONSTRUCTION PERSONNEL

(Estimated Breakdown at Maximum Employment)

Craftsmen		Number
Boilermaker		220
Bricklayer		30
Carpenter		180
Cement Finisher		20
Operating Engineer (Heavy)		140
Ironworker		150
Laborer		200
Millwright		90
Pipefitter		450
Teamster		10
Sheet Metal Worker		25
Electrical		215
Painting		35
Insulation		35
	Subtotal	1800
Management/Engineers		200
Miners		100
Construction Camp Service & Maintenance		150
	Total	2250

Paraho 1982

TABLE 2.2.5

PLANT AND MINE OPERATIONS PERSONNEL

(Estimates)

Personnel			Number
Plant Management/Engineering			40-50
Plant Operations			190-240
Shale Preparation		50-60	
Retort Operation		60-70	
Oil Upgrading		30-40	
Power Generation		30-40	
Material Storage/Shipping		20-30	
	Subtotal	190-240	
Plant Services			180-220
Maintenance		90-100	
Laboratory/Environmental		30-40	
Security/Emergency		20-30	
Labor/Services		40-50	
	Subtotal	180-220	
Mine Management/Engineering			40-50
Mine Operations			590-630
Miners		210-220	
Hauling/Crushing		100-110	
Processed Shale Disposal		140-150	
Maintenance		140-150	
	Subtotal	590-630	
	Total		1040-1190

Paraho 1982.

2.2.5 Other Resource Requirements

Other resources required for the construction and operation of the Paraho-Ute commercial facility include electricity, natural gas, propane, gasoline, diesel, fuel oil, air, explosives, chemicals, and catalysts. The estimates of these resource requirements reflect usages for construction and operation activities. Resource requirements associated with the delivery of raw materials, employee transportation, and product distribution (beyond the connection with the Chevron pipeline) have not been included. Nor have employee-related resource needs (e.g. socioeconomic impacts) been discussed in this report.

Electricity. Estimated electric power requirements for the project are presented in Table 2.2.6. The power requirements listed for the temporary construction camp, the surface facilities construction, the mine, shale handling and retorting, oil upgrading and power house facilities represent maximum usage.

During normal operations, on-site electric power cogeneration facilities will be producing electrical power from clean retort product gas for on-site usage. By late 1986, the cogeneration facilities will be producing an excess of electric power. This excess electric power will be sold back to the local grid system. During an unusual condition (e.g. all power generation units not operating while retorts are operating), the maximum electrical power that would need to be purchased would be 155 MW.

TABLE 2.2.6
(Estimated)
PARAHO-UTE ELECTRIC POWER REQUIREMENTS

(MEGAWATTS)

Year (1)	Const. Camp	Mine	Surface Const.	Shale Handling and Retort (2)	Oil Upgrading	Power-House	Total Load	Power Generated (on-site)
1983	3	4.5	2.5	-	-	-	10	-
1984	10	6	8	-	-	-	24	-
1985	10	10	8	12	-	-	40	-
1986	6	12	8	30	8	10	74	55
1987	1	21	8	80	20	25	155	160 (3)
1988	-	23	-	84	22	26	155	185 (3)
(4)	-	23	-	84	22	26	155	185 (3)

(1) Year equals estimated requirements at mid-year.

(2) Includes water and gas treatment requirements.

(3) On-site power generation exceeds power needs.

(4) Equals each subsequent year until the operations are completed.

Source: Paraho 1982.

Motor Fuels. The motor fuel requirements are provided in Table 2.2.7. These estimates are based upon construction and operation of projects having similar scope and size. The motor fuel requirements for the construction of the Paraho-Ute facility are presented as the total requirements for the entire construction period. The requirements for the operations represent maximum usage during project operations.

Other Fuels. Fuels, other than motor fuels and the cleaned off-gas, used while operating the Paraho-Ute facility are listed in Table 2.2.8. Estimated usage of natural gas is presented in million standard cubic feet per day (MMSCFD), while fuel oil and propane are presented in gallons per day (gpd). Propane will be used for the flare pilots and light-off, and will also be available as a substitute for natural gas in the event of a natural gas supply interruption.

Other Resources. The quantities of air, chemicals, and catalysts that will be required are presented in Table 2.2.9. The air requirements do not include auxiliary boiler, Stretford plant oxidizer blowers, nor hydrotreater furnace needs. The types and amounts of chemicals and catalysts listed in Table 2.2.9 do not include those needed for the hydrotreater, sour water stripper, and the boiler feed.

TABLE 2.2.7
(Estimated)
MOTOR FUEL REQUIREMENTS

	Fuel	Use	Amount Required
A. Construction[1]	Diesel	Mine & Surface Vehicles	600,000 gallons
	Gasoline	Surface Vehicles	600,000 gallons
B. Operation[2]	Diesel	Mine	11,730 gpd[3]
	Diesel	Surface[4]	5,000 gpd
	Diesel	Explosives Mix	286 gpd
	Gasoline	Surface Vehicles	3,000 gpd

(1) Amount represents total construction period usage.

(2) Requirements at full design operation.

(3) gpd = gallons per day.

(4) Also includes retorted shale disposal and shale fines storage.

Source: Paraho 1982.

TABLE 2.2.8
(Estimated)
OTHER FUEL REQUIREMENTS

Fuel	Quantity Required	Use
Natural Gas(1)	1.0 MMSCFD	Hydrotreater Charge Furnaces
	13.0 MMSCFD	Hydrogen Reformer Furnace
	15.0 MMSCFD	Hydrogen Reformer Feed Stock
No. 2 Fuel Oil(2)	885 gal.	Retort Start-up
	2,900 gal.	Auxiliary Boiler - Idle
	29,000 gpd	Auxiliary Boiler - Full
Propane(3)	168 gpd	Flare Pilots
	3,400 gal/hr (2-3 hour duration)	Flare Light-off

(1) Based on 1,000 Btu/SCF.

(2) Based on 130,000 Btu/gallon.

(3) Based on 91,500 Btu/gallon.

MMSCFD = million standard cubic feet per day.

gpd = gallons per day.

Source: Paraho 1982.

Paraho

TABLE 2.2.9
(Etimated)
OTHER RESOURCE REQUIREMENTS

Resource	Quantity Required (1)	End Use
Air	1.1 MM SCFM (2)	Plant and Instrument Air Retort Air Blowers Power Generation Hydrogen Plant Air Blower
Pour Point Depressant	12,360 lb/D (3)	Hydrotreated Shale oil Transport
Chemical and Catalysts	Lime 8,400 lb/D H_2SO_4 26,800 lb/D NaOH 4,400 lb/D Phosphoric Acid 3,400 lb/D Polymer 25 lb/D Chlorine 300 lb/D	Water and Wastewater Treatment
	Betz 220 5.6 gpd Betz Slimicide 364 5.7 gpd Betz 2040 15 gpd Chlorine 130 gpd	Cooling Tower
	Stretford Make-up Chemicals 380 lb/D Soda Ash 7,600 lb/D Catalysts: Zinc Oxide 250 ft^3/6 mo High Temp CO Shift 1,750 ft^3/2 yr Low Temp CO Shift 2,600 ft^3/2 yr Methanater 600 ft^3/2 yr Reformer 1,500 ft^3/2 yr Arsenic Guard Bed 9,600 ft^3/6 month	Stretford Units

(1) During normal operations.

(2) MM SCFM = million standard cubic feet per minute.

(3) lb/D = pounds per day.

Source: Paraho 1982.

2.3 Project Schedule

A detailed project schedule is provided in Figure 2.3.1. Several critical milestones in this schedule could delay the project and escalate costs if not met. These include:

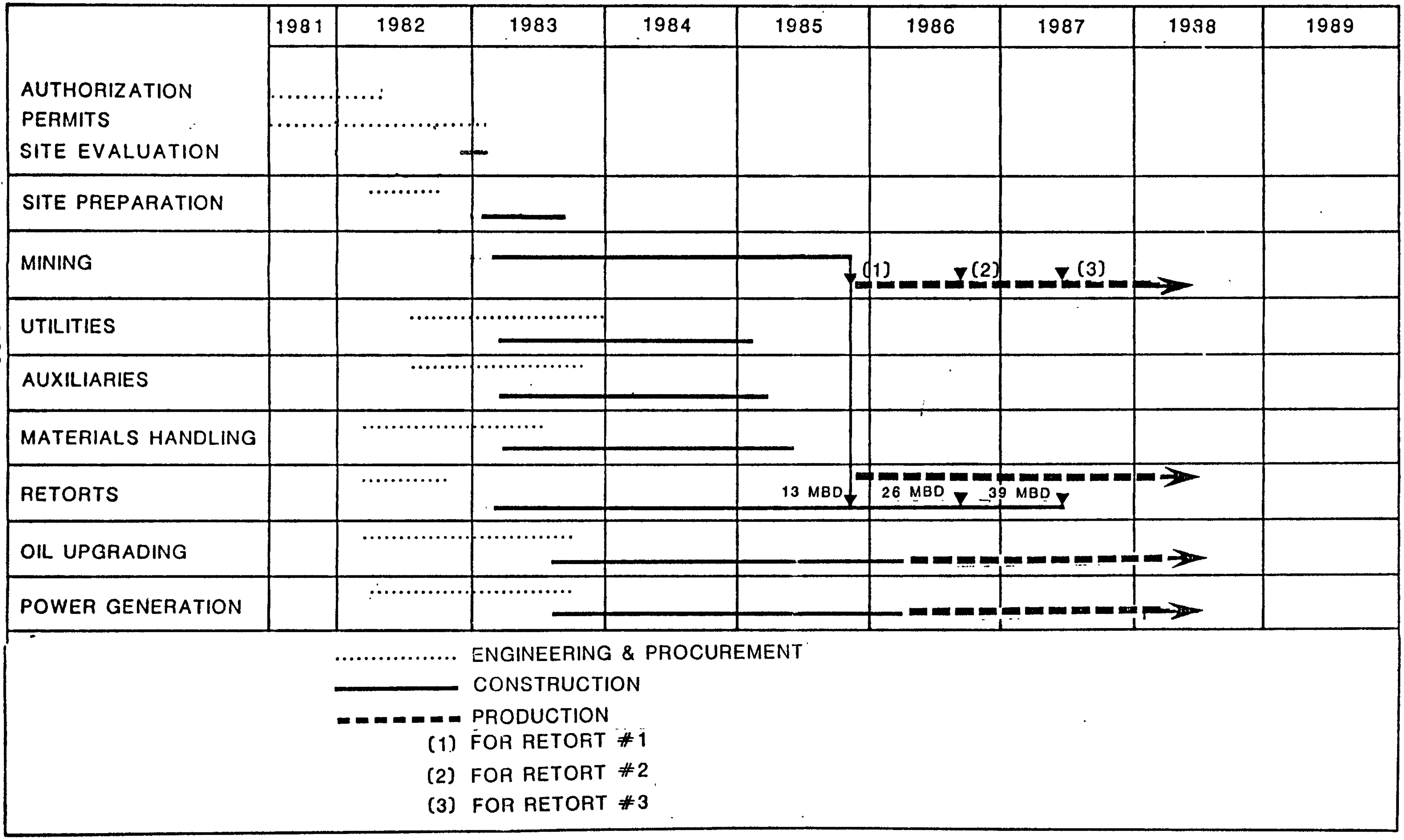
o Acquisition of necessary permits and start of site evaluation	1982
o Financing	1982
o Federal actions pending final EIS	1983
o Completion of first phase of construction and startup of operation	1985
o Begin full operation	1987

2.3.1 Construction

The schedule of construction is shown in Figure 2.3.1. Site evaluation will begin in late 1982 following receipt of permits, licenses, and rights-of-way necessary for the construction of the Paraho-Ute facility. Construction will start about March, 1983. The construction program will require 60 months overall with about 36 months to complete the first retort module and associated facilities and about 18 months to construct the second and third retort modules.

FIGURE 2.3.1

PARAHO DEVELOPMENT CORPORATION
BASE SCHEDULE



In general, items to be completed first will be those which are essential to, or facilitate, the construction effort. Included will be items such as improvement and/or construction of access roads, site grading, provision for electrical power, water supply to serve both potable and dust suppression needs, sanitary waste treatment facilities, temporary housing facilities, and appropriate ditching to divert surface water from the construction area.

Subsequent construction will include the major facilities for shale handling, retorting, gas treating and oil recovery, raw oil shale fines storage, and retorted shale disposal. Also included are numerous auxiliary facilities necessary to support a retort operation. These include, but may not be limited to, the following: electrical supply and distribution; sewers; water supply, treatment, storage, and distribution for potable, process, fire water needs; process wastewater and sewage treatment facilities; oil storage and shipping facilities; steam and electric power generation; repair shops; offices; warehouse; laboratory, roads; parking; and fences.

Construction of oil upgrading facilities will be completed after the first retort is on-stream. Crude shale oil produced until that time would be stored on site.

There will be several items with lifetimes shorter than that of the proposed project. These include:

- Construction camp (to be dismantled completely by the end of 1987).
- Mine excavation rubble (to be used for fills, rip-rap, retention dams, etc.).
- Preoperation shale produced from mine development activities.
- Storage of oil shale fines produced during shale crushing and screening.

2.3.2 Operation

After construction of the first retort is completed, start-up will occur in late 1985 (see Figure 2.3.1). The first hydrotreater will come on-stream around April, 1986. At this time, the crude shale oil that will have been stored will be upgraded. The second retort will start producing crude shale oil in mid 1986. Full production will begin in late 1987 when the third retort and all auxiliaries are fully operational. About 10 years of production are anticipated from the reserves contained in the present site.

2.3.3 Post-Operation

Although the date of the project completion is not firmly established, details of abandonment and reclamation procedures have been established and are presented in Section 2.4.3. Present shale reserves would result in production and operation completion about 1955; however, the acquisition of additional shale reserves would extend the project life such that full operation can be maintained for more than 30 years.

Site abandonment will commence with the removal or demolition of surface facilities. Any salvageable items will be sold at that time. All mine openings will be sealed. Revegetation and reclamation will commence on the processed shale disposal pile immediately and on other areas of the project site when the surface facilities have been removed. It is estimated that at least three years will be required to complete the reclamation work. Monitoring operations will be carried out for at least five years.

2.4 General Construction, Operation, and Reclamation Procedures

This section describes the standard, or general, practices that will be employed to mitigate potential impacts during the construction, operation, and reclamation phases.

Additional information concerning the general mitigation procedures employed during the construction, operation, and reclamation phases can be found in the permit applications filed by Paraho with the Environmental Protection Agency (EPA) and the State of Utah. These applications include: Prevention of Significant Deterioration Permit (Pforzheimer 1981), Notice of Intention to Commence Mining Operations Permit (Pforzheimer 1982), National Pollutant Discharge Elimination System Permit (Lukens 1982), and Solid Waste Disposal Permit (Lukens 1982).

2.4.1 Construction Procedures

The potential impacts caused by large scale construction projects include increased dust, noise, and the potential for discharging silt-laden water into natural streams. Mitigation procedures for these impacts are discussed under General Procedures. Another impact of construction project is the influx of a large number of temporary workers into a region which creates increased travel, noise, and demands on housing and infrastructure of the region. The impacts are not discussed in this report; however, mitigation of the impacts is discussed under Construction Camp.

<u>General Procedures</u>. Normal measures will be taken to mitigate impacts caused by construction. These measures include the following:

- All existing improvements (e.g. fences, pipelines, etc.) along project-related linear facilities (pipelines, transmission lines, etc.) would be protected, and any damage due to construction would be repaired.

- Fugitive dust generated during construction will be suppressed as necessary to comply with air quality regulations. Emissions will be controlled using wet suppression, paving main traveled areas as soon as practical, revegetating stockpiled soils, and controlling the amount and speed of motor traffic.

- Appropriate landscaping will be provided to prevent discharge of sediment-laden runoff to the White River. Temporary diversion channels, energy dissipators, and retention structures will be used wherever practical. Exposed cuts and fills would be protected against erosion.

- Paraho will coordinate with all regional, county, and local officials in planning, scheduling, and implementing development and construction. This will aid local governments in planning for project-related community impacts.

- Appropriate road signs for public safety purposes would be provided during construction. Flagmen, barricades, and other safety measures would be provided to insure public safety.

- Paraho will comply with appropriate permitting authorities for transporting heavy components.

The development of the underground mine requires some special control measures to reduce risks to miner safety in areas of cave-ins and rock falls, gassy conditions, and mine flooding. These special measures include the following:

- All loose rock will be removed and the back (ceiling) securely roof-bolted as the main development advances. The stability of the back will be monitored using sagmeters to assure structural integrity.

- Although the existing data obtained from core hole examinations and Paraho's experience with adit-entry mines suggests that the mine will be classified non-gassy, the design of the ventilation air system is based upon gassy conditions. A temporary air duct system will be used to assure fresh air during construction.

- Although data obtained from core hole examinations and on-site geological studies suggests that the mine will be dry, a pump system has been designed to dewater the mine and prevent mine flooding.

- All mine construction workers will receive safety training as required by MSHA.

Construction Camp. In order to mitigate the potential impacts on the existing regional communities, Paraho is planning to construct temporary living quarters for construction personnel. This will be a temporary camp which will be utilized during the construction phase only. After the mine and plant construction is completed, the camp will be dismantled and all disturbed areas will be reclaimed using approved revegetation techniques or prepared for future use (such as retorted shale disposal).

Members of Paraho's permanent work force are expected to reside, for the most part, in the existing regional communities. Unlike the temporary construction work force, these permanent workers will become part of the established communities.

The proposed location of the temporary construction camp is on the Paraho site. This site is in the southwest corner of Section 6

(Township 10 South, Range 25 East) on a plateau just north of the White River and west of the large canyon which bisects Section 6. The location is a fairly level, treeless plateau situated about 300 feet above the river level.

Access to the camp will be by a road leading from the main site access road in the NW¼ of Section 30 (T9S, R25E) south to the camp in Section 6 (T10S, R25E) (see Section 2.5.8). This off-site access road would serve as the principal access for the construction work force residing in the camp. A right-of-way is needed for this road.

Travel from the camp to the main construction area is by a two-mile road that exists completely on-site. Because of the anticipated volume of traffic on this road, it will be paved to reduce fugitive dust and to provide safe, all-weather transportation.

The area required for the construction camp is approximately 100 acres. This size is adequate to accommodate the peak work force anticipated to reside in the camp. The facilities at the camp will be constructed to accommodate the anticipated work force as it rises to a peak then falls as the mine and plant construction is completed.

It is estimated that about 70% of the construction work force will live in the temporary camp. Of the remaining 30%, it is anticipated that about one-third, or 10% of the total work force, will be comprised of persons already residing in the regional communities. Accommodations for families with children will not be included in the construction camp.

The design, construction, operation, and dismantlement of the camp will be subcontracted to a firm specializing in that work. General details of the camp will include:

- o Motel-like accommodations with private room and bath in 500-unit modules.
- o Convenient parking areas.
- o Sites that can provide full service for 200 mobile homes or RV's.
- o Community centers which house food service, recreation, and plant administration with additional features that include a library, chapel, and lounging areas.
- o Additional common areas in the living quarters for phone service, laundry service, and recreation.
- o Full range of out-door recreation areas.
- o Transportation to the construction site for all construction workers.
- o Safety, health care, and security.

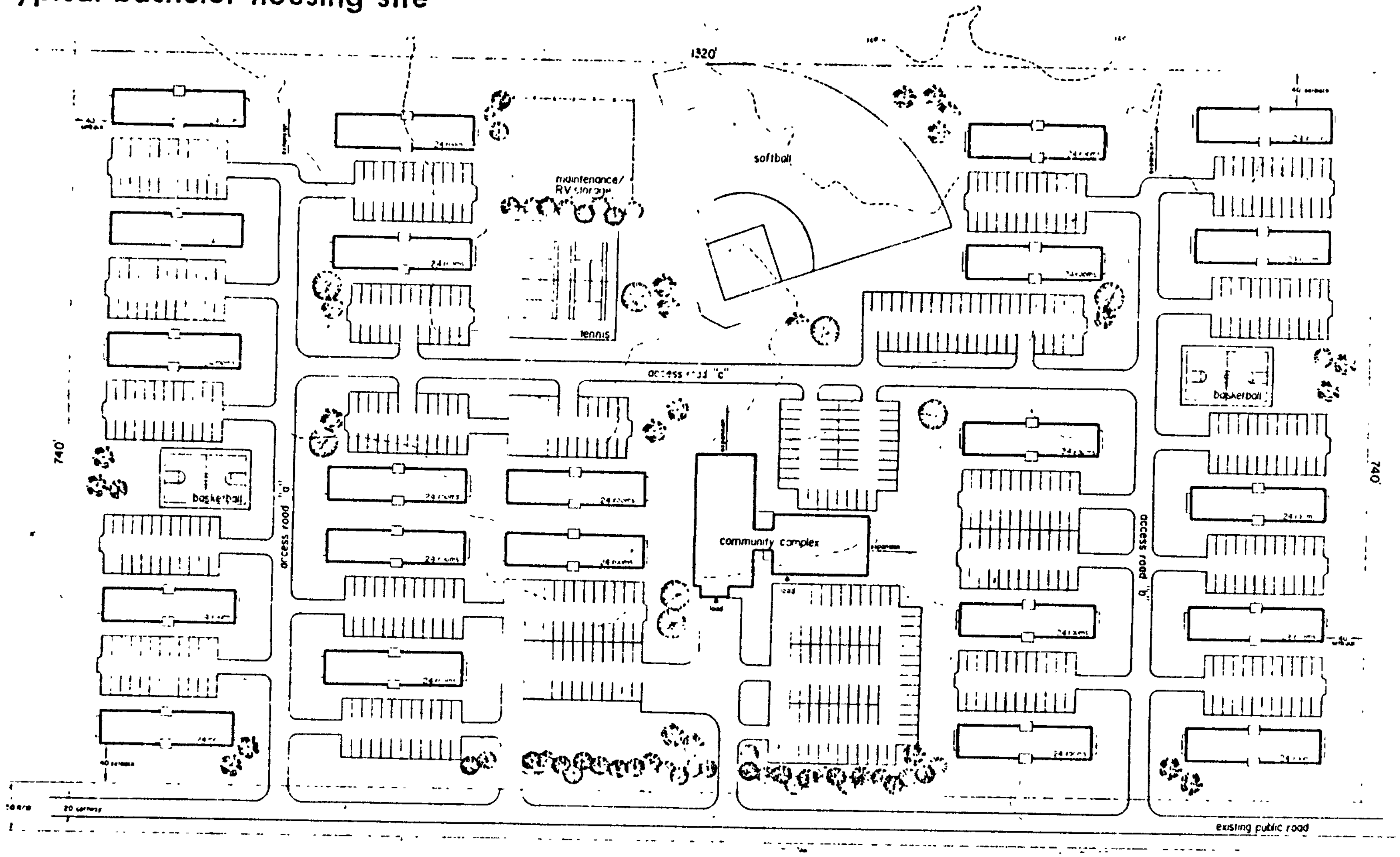
Figures 2.4.1 and 2.4.2 depict typical layouts of the living quarters and a community center planned for the temporary construction camp.

The temporary construction camp will be designed to provide living facilities and leisure recreation for the construction work force in order to:

- o Improve worker satisfaction, thereby minimizing the percentage of turn-over.

Figure 2.4.1

typical bachelor housing site



data

occupancy - 528 rooms
area - 22.4 acrus
density - 23.6 rooms per acre

SITE PLAN
500± Room Bachelor Housing Project

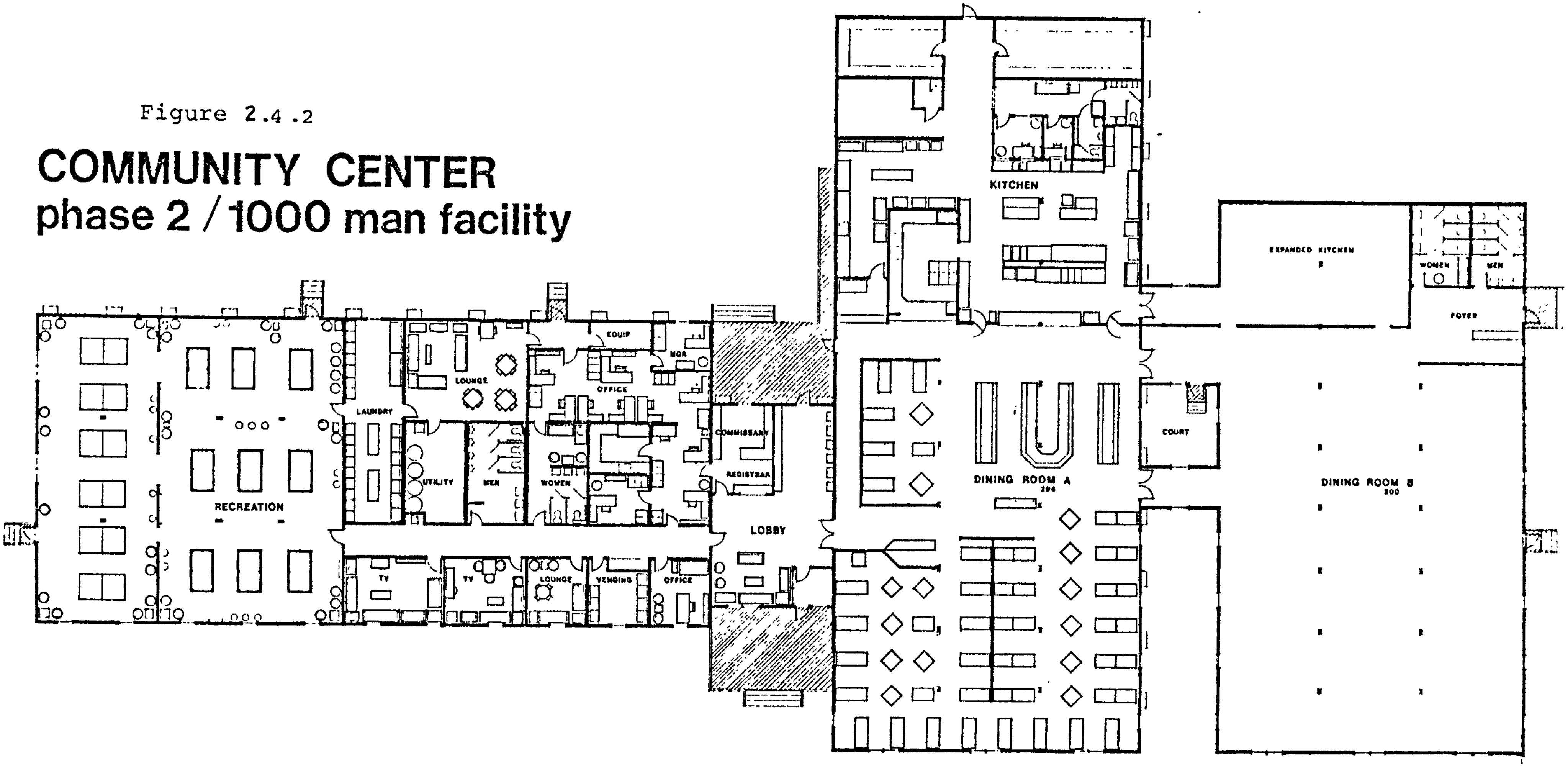
holleran services, inc.

N

1

Figure 2.4.2

COMMUNITY CENTER
phase 2 / 1000 man facility



HOLLERAN SERVICES INC.

MAIN OFFICE:
3550 KINGSTON CENTER
YORK, PENNSYLVANIA 17402
717-757-8442

WESTERN REGION:
25283 CABOT ROAD SUITE 215
LAGUNA HILLS, CALIFORNIA 92653
717-770 8355

- Provide attractive lifestyles that would minimize off hour traffic to regional communities, thereby reducing even further any adverse impacts.

- Reduce the impacts on existing communities.

2.4.2 Operation Procedures

The general procedures for mitigating potential impacts are listed below:

<u>Air Emissions Control</u>

- Particulate emissions from mining will be controlled by baffled settling and wet suppression.

- Particulate emissions from primary crushing and in-mine transfers will be controlled by baghouses.

- Particulate emissions from secondary and tertiary crushing units will be controlled by baghouses.

- Dust generated from conveyors and conveyor transfer points will be controlled by covers and enclosures. Dust contained in these covers and enclosures will be controlled by the use of baghouses or wet scrubbers.

- Fugitive dust from storage piles will be controlled by wet suppression.

- Fugitive dust from haul roads will be controlled by wet suppression, oiling, or paving.

- The Stretford units will remove H_2S prior to combustion of the product gas.

- A water wash system will reduce ammonia in the product gas prior to combustion to minimize NO_x emissions. Special low-NO_x burners will further reduce these emissions.

- H_2S in the hydrotreater purge gas will be removed by a Stretford unit.

- Off-gas from the wastewater treatment unit will be treated in a Stretford unit for H_2S removal and recovery.

- Hydrocarbon emissions from storage tanks will be controlled by floating roof tanks, vapor return systems, or buried tanks.

Wastewater Management

- Sanitary wastewater will be treated in a package sanitary wastewater treatment system and be re-used as non-potable water.
- Sour water (containing H_2S and NH_3) will be treated in a sour water stripper unit for H_2S and NH_3 removal.
- Process contaminated runoff, gas clean-up wastewater, retort wastewater, process wastewater and blowdown streams will be appropriately treated according to end use; i.e. re-used, used for retorted shale wetting, or evaporated. No wastewater will be discharged.
- Static water level measurements will be taken at appropriate intervals at monitoring wells to record any changes in the groundwater regime. Parameters including water temperature, specific conductance and pH will also be analyzed. A complete laboratory analysis of appropriate physical and chemical parameters will be taken as deemed necessary.

Solid Waste Management

- Retorted shale will be disposed of above ground. Low permeability retaining structures and liners of highly compacted, moistened retorted shale will be used to provide protection against erosion. The system will be designed to minimize leachate from the disposal area. Completed areas will be revegetated.
- Non-hazardous sludges from the wastewater treatment facilities, plus garbage and scrap will be disposed of with the retorted shale.
- An approved sanitary landfill will be used for disposal of construction debris and scrap generated during the early phases of construction. This landfill will be closed when the facility becomes operational.
- Hazardous wastes will be transported to approved off-site disposal sites using the services of an approved transporter.

Other special mitigation procedures to be carried out during the operation of the Paraho-Ute Shale Oil Facility for the protection of the workers are:

- Employee safety and hygiene training; oil resistant worksuits, gloves, and other protective equipment; and a high degree of automation will limit dermal contact with crude shale oil.

- Masks, respirators, or other protective measures will be used in emergency situations to prevent potential inhalation of suspected harmful effluents and particulates.

- Mufflers and baffles incorporated in plant design will reduce noise generated from rotating equipment to standard safety levels; in emergency situations, earplugs, muffs, or other protective measures will protect employees.

- Sealed and air conditioned cabs of vehicles, control rooms, and work areas will provide a controlled working atmosphere.

2.4.3 Reclamation Procedures

Pursuant to the Mined Land Reclamation Act, the State of Utah requires that all mined land abandoned after June, 1978 be reclaimed in a manner which is capable of supporting a post-mining use that is compatible with probable land uses.

The reclamation activity will be implemented as described in Paraho's Intention to Commence Mining permit application, filed in March, 1982, with the State of Utah's Division of Oil, Gas, and Mining (Pforzheimer 1982).

Generally, this activity will include removal of all surface facilities and debris, sealing all mine portals and shafts, and final stabilization of the retorted shale disposal and shale fines storage areas. In addition, recontouring of the land surface and revegetation of all disturbed areas are required.

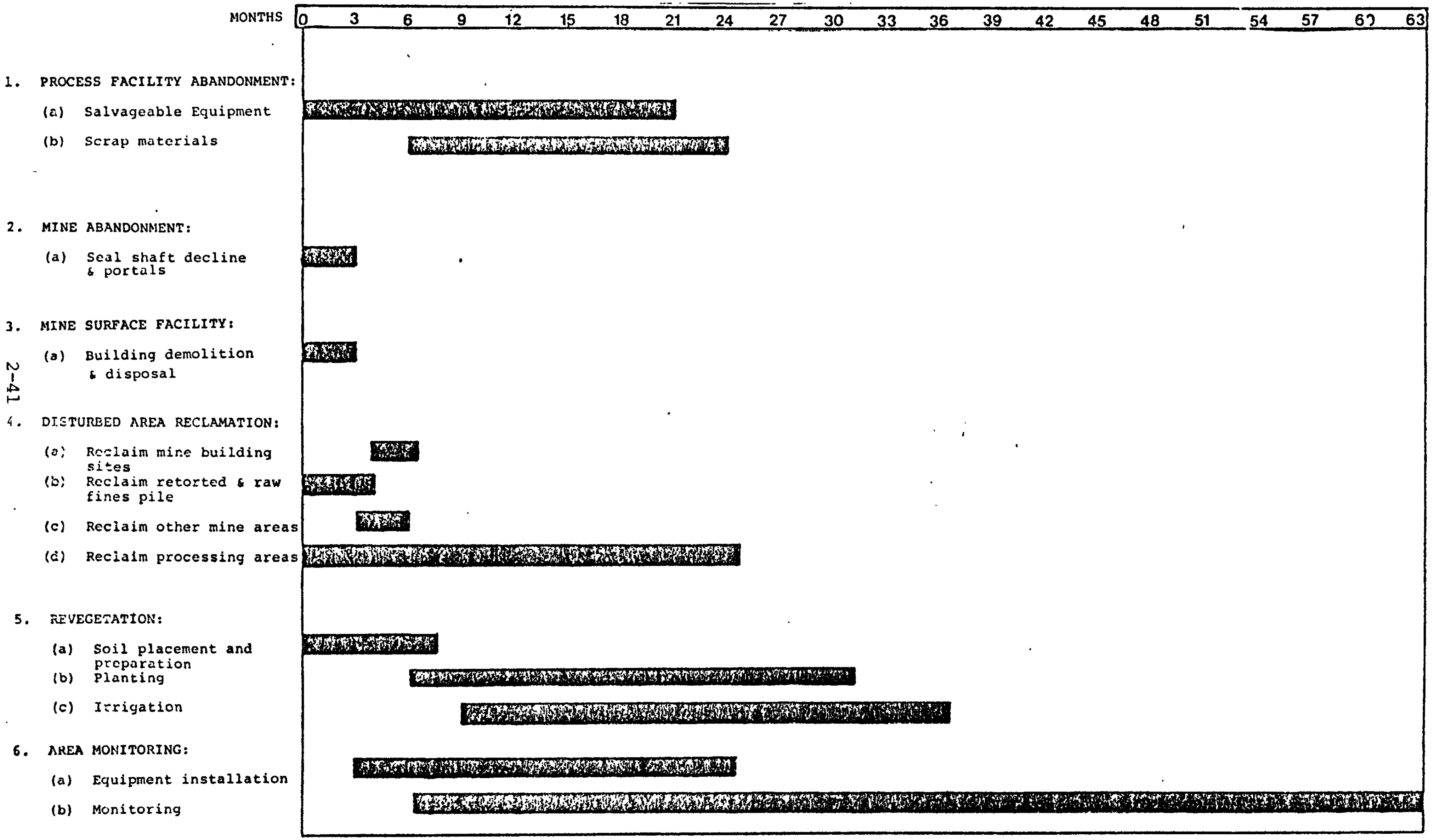
Abandonment Schedule. Figure 2.4.3 presents a schedule for the tasks to be undertaken at the time of abandonment of the Paraho-Ute facility. Most of the reclamation work will be completed within one year after mining and retort operations have ceased. After that time, a limited staff will be required for vegetation and retorted shale pile monitoring. The monitoring results will determine whether or not additional reclamation efforts are needed. Monitoring will continue as needed until reclamation procedures are completed.

Reclamation of arid lands is most successful when soil moisture is maximized. Reclamation procedures carried out in the fall maximize the accumulated soil moisture that is produced from snowfall. Therefore, Paraho, whenever possible, will utilize fall seed bed preparation, seeding, planting, and fertilizing throughout reclamation of the plant area and retorted shale pile.

Mine Abandonment. Mine abandonment consists of the removal of salvageable equipment and ventilation fans and the sealing of the mine shaft and portals. The service shaft will be sealed by forming and pouring a concrete plug at the shaft surface. This concrete will be supported by existing structural steel in the shaft, augmented with additional structural steel where needed.

FIGURE 2.4.3

ABANDONMENT SCHEDULE



The other shafts will be sealed in a similar fashion. The mine portals will be sealed by constructing a concrete wall within the entrance. Suitable rock and other materials will be backfilled against the wall to camouflage the openings.

Removal of Surface Structures. When the Paraho-Ute facility ceases operation, all surface installations will be removed. All trash, unsalvageable scrap metal and wood, building debris, extraneous debris, and other materials will be disposed of by on-site burial in an approved location.

Regrading Plan. It is estimated that up to 700 acres of disturbed lands will require reclamation and revegetation. This area includes the retorted shale disposal area, raw shale fines storage area and all other areas disturbed by construction of surface facilities. Recontouring and grading of all disturbed areas to approximate original contours will provide terraces that minimize erosion, prevent heavy sedimentation loads in surface run-off from contaminating the White River, and permit the establishment of vegetative cover.

The raw shale fines storage and retorted shale disposal areas will be contoured in broad terraces sloping toward the center of the piles during the final placement of materials on these piles. The sloping of the benches and tops of the piles enhance the water harvesting design of the revegetation program. The evapo-transpiration rates of this arid environment will quickly utilize any runoff water found in these areas.

Slope Stability. The grades of all artificially created slopes will ensure their long-term stability. High safety factors were calculated during engineering analyses of pile embankments for the retorted shale pile and the raw shale fines pile (Paraho 1982).

In addition, the sloped faces of the retorted shale pile will be constructed of moistened and highly compacted shale material to form a water-impervious layer. This layer will be overlain with a protective rip-rap facing. This combination of treatments, coupled with flat benches to intercept any runoff water, will assist in the long-term stability of this slope.

Runoff Control. A combination of terracing, contour ripping and scarifying will be used to minimize erosion from the project site. Benches will be provided at various increments on the embankment faces of the retorted shale disposal pile. These benches will include high berms to provide containment of precipitation runoff of the 24-hour, 100-year design storm. This provision precludes the requirement to install runoff collection ditches around the entire perimeter of the pile.

Collection ditches, constructed on the west side of the retorted shale pile, will gather precipitation runoff from the lower slopes of the retorted shale embankment and divert the water to a collection-evaporation pond. The ditches will be equipped with energy dissipators to reduce flow velocities at the confluence of the ditches and the retention pond.

Two retention ponds will be constructed to receive precipitation runoff from the retorted shale pile. A third collection pond will be located south of the raw shale fines storage area.

Based on monitoring results and approval by the State of Utah, these three retention ponds may remain in place after abandonment. If the monitoring results of these ponds show no large amount of seepage or runoff water from the piles or no large amounts of pollutants in any impounded water, these ponds will be reclaimed.

Soil Replacement. The tops and the horizontal benches of the retorted shale pile and raw shale fines pile will be covered with a six-inch layer of coarse material to prevent upward capillary movement of saline and sodic waters from the piles. After surface sites have been graded to approximate original contours, surficial soils, which have been stripped from these areas and stored prior to construction, will be replaced to a minimum thickness of 14 inches.

The layer of surficial soils will be spread uniformly to retain the required slope, and terraces will be placed over the recontoured areas of the reclaimed building sites and the retorted shale and raw shale fines piles. Compaction of soil layers replaced will approximate that of the layers in natural surrounding soils.

Revegetation. Paraho's revegetation plan is designed to return the reclaimed areas to their pre-operation use of limited grazing.

Paraho plans a two-phase approach to establish vegetation on disturbed areas.

1. Transplant container-growing seedlings, shrubs, and perennial grasses.

2. Seed and fertilize the disturbed areas with native and introduced grasses, forbs, and shrubs. Irrigation is planned during the first growing season so that plants can become established.

The transplanting of container-grown plants will be used to develop a rapid, partial vegetative cover over the disturbed areas. The container-grown plants will be fertilized and irrigated during the first growing season to insure successful establishment in the new environment.

The test embankment and fill area of the retorted shale pile will be utilized as a test area for revegetation, as will other test plots on-site, during the operation of the facility. The revegetation test plots will be designed to determine appropriate species, seed mix, soil preparation, and seeding methods.

<u>Monitoring</u>. When the Paraho-Ute facility ceases operation and the reclamation of the retorted shale pile is complete, a monitoring program, initiated during operations, will be continued to evaluate the stability and performance of the pile. Monitoring will include

measurements of pile moisture, phreatic water levels, retorted shale pile temperature, leachate water quality (if present), embankment stability, and vegetation.

The monitoring will also be used to measure the success of revegetation efforts. This includes the following:

- o Conduct annual vegetation transects in selected areas.
- o Coordinate the vegetation transects with color IR photographs.
- o Measure and tag individual plants to assess growth rates.

2.5 Project Components

This section provides a description of the major project components for the commercial facility. These include: mining, shale handling, retorting, oil recovery and upgrading, gas clean-up and utilization, air emissions control, solid waste disposal, by-product handling, water use and treatment, oil and other fuel storage tanks, and off-site facilities and rights-of-way.

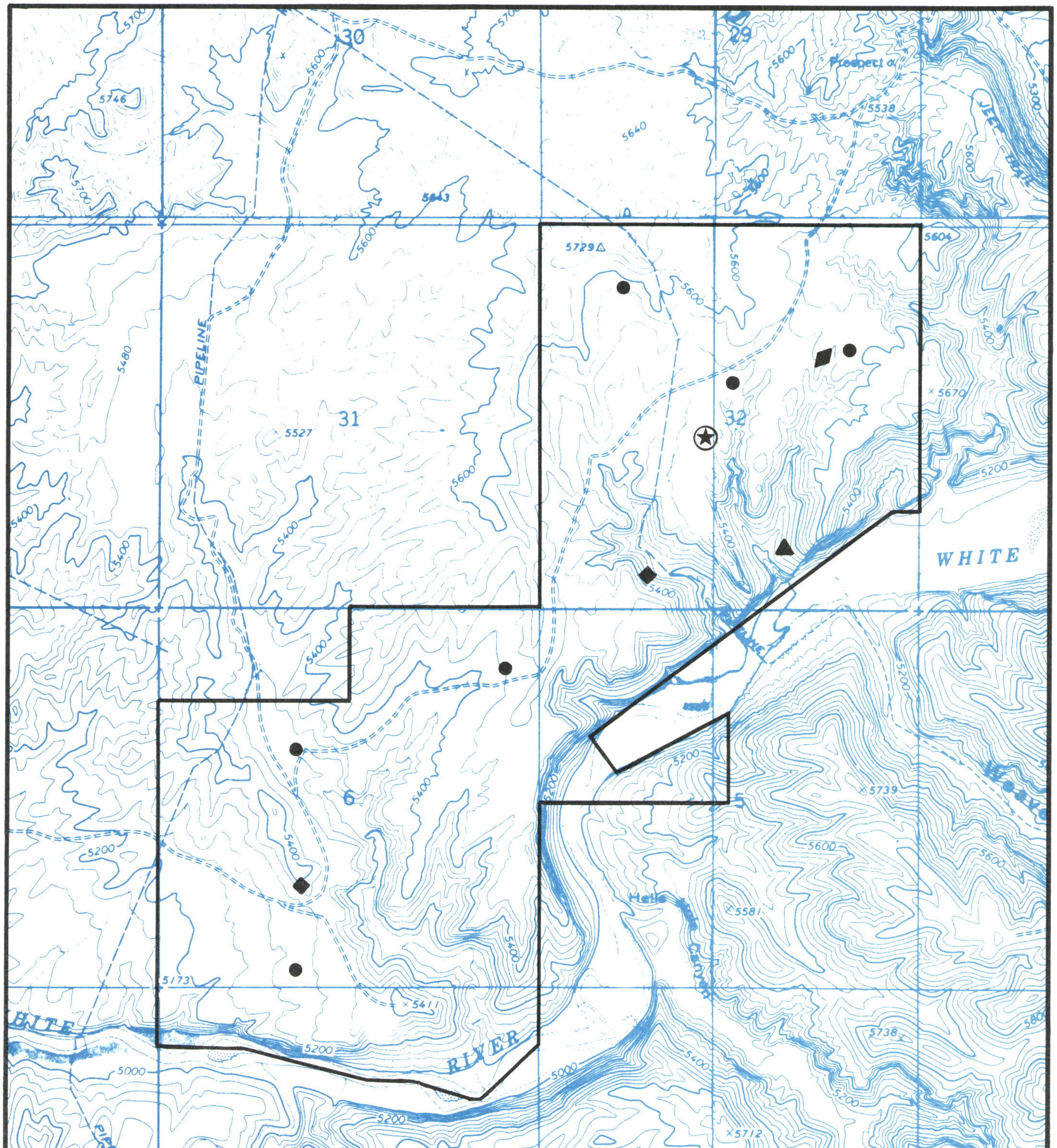
2.5.1 Mining

Mine Description. The Paraho mine will be an underground room-and-pillar mine. All headings and cross cuts will be approximately 45 to 55 feet wide. Pillar sizes will vary depending upon surface activities, rock mechanics, and thickness of overburden. Overburden at the Paraho site varies from 400 to 900 feet. Pillar sizes will vary from 57 x 57 feet to 85 x 85 feet. Thus, the amount of material removed from the mining zone will be approximately 62% of the available resource. The locations of plant operations, storage piles, and the retorted shale disposal area were considered in designing pillar sizes.

The height of the mining zone will be about 77 feet. According to assayed core intervals, this mining zone will produce oil shale within the 26 to 30 gallons of oil per ton range as planned for retort operations.

The approximate locations of the main access shaft, the incline conveyor drift, and the ventilation drift and shafts (as well as the test core holes) are shown in Figure 2.5.1. The main access to the mine will be a vertical service shaft about 550 feet deep. The incline drift, about 14 feet high by 16 feet wide, inclined 15 degrees, will house the conveyor that will transport the crushed shale to the surface. The incline will extend from the mining zone, at the base of the main access shaft, to the surface at the shale preparation-storage area located in the northeast section of the plant complex.

Two air intake adits, about 45 feet high by 45 feet wide, will be driven from the canyon wall near the White River in Section 32 into the mine (see Figure 2.5.1). A mine access road constructed to the air intake entrance will be used for transporting the large machinery into the mine. Two vertical exhaust shafts are planned for the commercial mine at locations shown on Figure 2.5.1. Fans will exhaust air from the ventilation shafts to stacks. The five million CFM (cubic feet per minute) design flow will provide adequate ventilation air for a "gassy" mine classification although "gassy" conditions are not anticipated. A small volume of air will be drawn down the main access shaft to ensure fresh air in that area. A fraction of the exhausted air will be exhausted up the incline to prevent any air intake at that point.



LEGEND

PROJECT BOUNDARY

EXHAUST SHAFTS

INCLINE CONVEYOR DRIFT

BENCH PORTAL (AIR INTAKE)

CORE HOLES

VERTICAL SHAFT (MAIN ACCESS)

SCALE: 1" = 2000 FEET

Contour Interval 40 feet

N

LOCATION OF MINE ACCESS AND VENTILATION FACILITIES

FIGURE 2.5.1

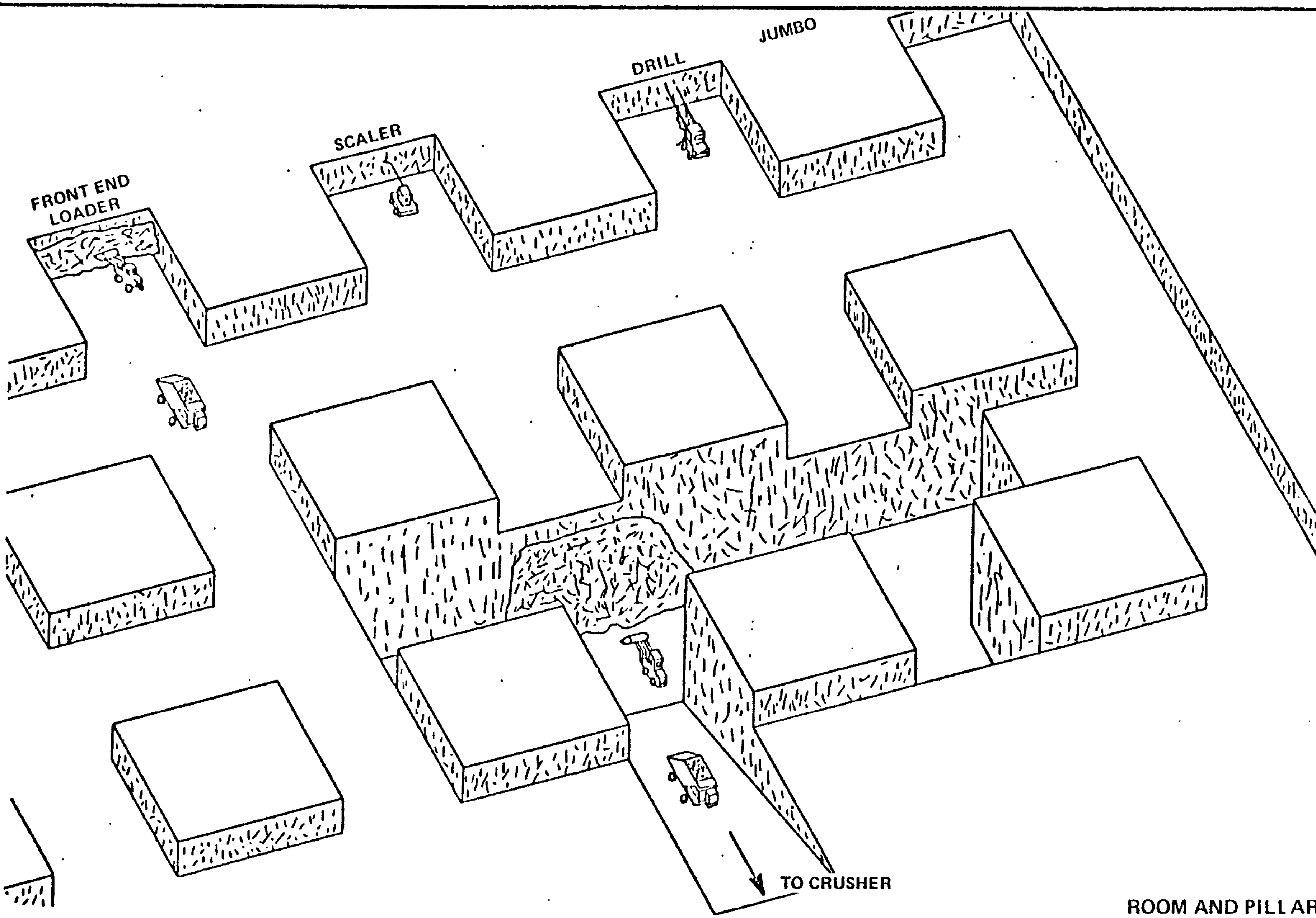
Mine Operations. The mine operations will consist of a heading (upper level) and a bench (lower level) (Figure 2.5.2). The two operations require different size equipment; however, the sequence of mining is: drilling, charging, and detonating; then loading, hauling and dumping the oil shale from the blasted area to the primary crusher; followed by scaling and roof bolting.

The horizontal drilling for the heading will be done by a drill jumbo. The jumbo will be self-contained with water/detergent tanks for dust suppression and an electric air compressor for drill hole cleaning.

A mixture of ammonium nitrate and fuel oil (AN/FO) will be the primary blasting agent. Bulk AN/FO will be loaded directly into a charging unit at a surface mixing plant. The charging unit will subsequently be lowered underground via the service shaft and will travel to headings scheduled for charging.

The charging and blasting of the drill round will advance the heading. Charging will be performed from an elevating basket mounted on an explosives charging unit. Each drill hole will be pneumatically loaded with AN/FO.

The loading in the production headings will be done by front end loaders. The loaders will also be used for cleanup required in the headings after blasting and scaling.



ROOM AND PILLAR
TWO BENCH MINING SYSTEM

FIGURE
2.5.2

The heading production hauling will be done with diesel, low-profile, bottom-dump trucks. The dump area at the primary crushers will accommodate the haul trucks used in the mine.

Following the load-haul portion of the mining cycle, the newly exposed faces and ribs will be scaled to remove loose rocks and produce a safe working area. The area will be cleaned with front end loaders and mucked with the material resulting from the next shot.

Roof-bolting will be done by a roof-bolting jumbo. The bolting unit will be capable of bolting the roof area exposed by blasting. The roof-bolting unit will be self-contained with a water/detergent tank for dust suppression and a compressor for purging drill holes.

Bench mining will use rotary blasthole machines for vertical drilling. The drill will be crawler mounted and equipped with a drilling unit. The unit will have a dust collection system and a controlled atmosphere cab.

Bench headings will be advanced with each charging and blasting of the bench and will differ from the upper heading in that the AN/FO will be gravity loaded from a bulk handling truck.

Production loading will be done with front end loaders. Hauling will be accomplished with diesel-powered, bottom-dump trucks. The number of haul trucks in use will depend on the distance between production areas and the dump point.

Until a panel is mined out, additional scaling plus periodic rib and roof inspection will be required to insure safe working conditions. In addition, an aerial platform will be used for detailed back inspection and monitoring.

All equipment used in the underground mining operations will be MSHA approved.

Primary and secondary shale crushing units are located at two places in the mine; one near the center of Section 6 and one near the base of the incline drift in Section 32. Each crushing unit consists of a single primary crusher and two secondary crushers. Broken shale hauled by truck to one of the primary crushers will be crushed to less than twelve inches in size.

Crushed shale from the primary crusher will be conveyed to an adjoining secondary crusher where the shale will be crushed to less than six inches in size. The secondary crushed shale is then fed by conveyor to the base of the incline conveyor which will transport the shale to the surface.

Dust Control. All muck piles, including those in drifts and top headings, will be moistened with water before loading. All haul roads will be periodically watered and regularly maintained to provide suitable hauling conditions. Dust generated at the primary and secondary crushers will be controlled using baghouse collectors. Baghouse exhaust air will be ducted to a return air passageway. Collected dust will be moistened with a dust conditioner.

Two additional conveyor transfer points, located in the mine, will require dust control. Since these points are remotely located with respect to the primary and secondary crushers and to each other, a separate bag-type dust collector will be required for each transfer. Collected dust will be replaced on the conveyor past the transfer point.

Mine Production. The mine production rate of up to 75,000 TPSD is based on 20 work shifts per week, thus up to 25,000 tons are mined in a single shift. Six days of mine production per week are based on 3 shifts per day, while the last day is based on 2 shifts per day. The remaining shift will be used for maintenance of the mine. In order to calculate the maximum emission per stream day, a mining rate of 75,000 TPSD is used. Average mining rate per stream day is 71,440 TPSD.

Based on Paraho's previous operations, an on-stream factor of 90% has been assumed. The yearly mine production would be 90% of 365 days (330 days at 75,000 TPSD) or 24 million tons per year.

Underground Facilities. Underground facilities will include bays designated for equipment maintenance and repair, supply warehousing, refueling and an area for offices, first aid station, and lunchroom.

The underground maintenance shops, warehouse, and offices will be located in an area near the service shaft. Large equipment bays will be provided for maintenance and repair of mining and haulage equipment. Adjacent smaller bays will be provided for repair and maintenance of service vehicles. Travelways providing access to the shop area will be graded and gravel surfaced.

Offices for shift supervisors will be provided near the warehouse and maintenance shops. A lunchroom and a first aid room will be included.

A warehouse for underground supplies will be located near the maintenance shops. It will have a concrete floor and a truck-height dock to facilitate truck loading and unloading.

Delivery and distribution of all needed supplies from surface to underground will be a major function. Equipment used to transport materials will be capable of moving on and off the service shaft cage while loaded, thus minimizing rehandling of mine supplies.

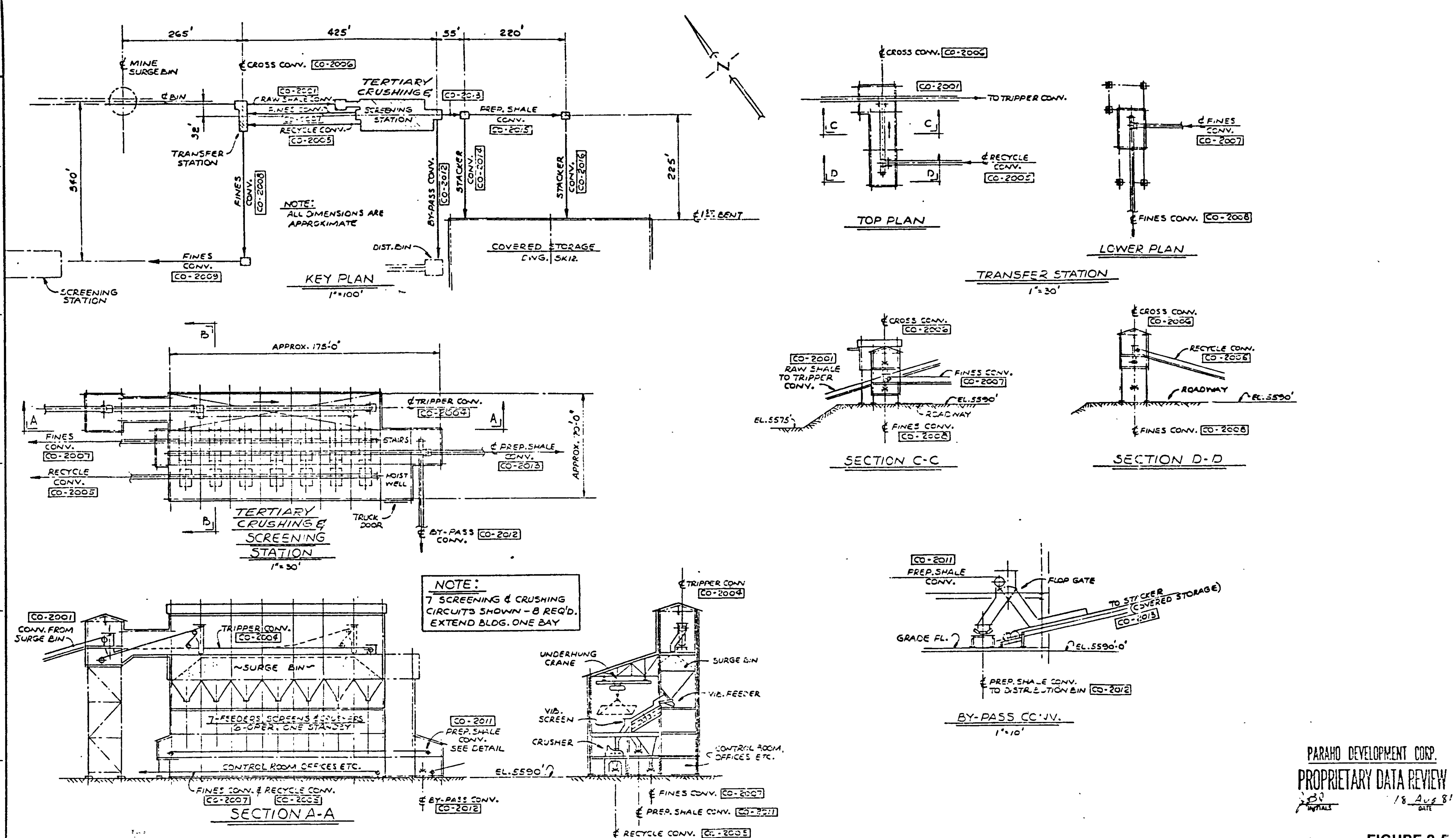
A diesel fueling station will be constructed near the underground shops. This facility will provide convenient refueling of haulage trucks and other vehicles which are not serviced at a mining face. The fueling system will be provided with safety controls and will meet MSHA requirements.

An underground bulk lube oil facility will be located adjacent to the shop area. Dispensing modules will be placed in a lube bay and in stratégically located stations in other areas of the maintenance shops. A complete underground-to-surface telemetry system and a fire extinguishing system will also be included.

2.5.2 Shale Handling Facilities

<u>Shale Handling</u>. Primary and secondary shale crushing will be accomplished underground. The less than six-inch sized shale is then transported to surface by an inclined conveyor. Normally, shale will be fed to tertiary crushing from the inclined conveyor via two feeders. The distribution system involved with the tertiary crushing, as well as the screening and transfer stations, are presented in Figure 2.5.3. An alternate system feeds shale to an uncovered emergency storage pile.

The tertiary crusher, which provides final shale size reduction, is a double-roll crusher system. Shale feed to the crushers is uniformly distributed by a tripper conveyor and surge bin system. The shale is sized prior to crushing; only oversized material is fed to the crusher. Crushed product material is recirculated to the feed system for further size classification. Final sized material (less than three inches to greater than three-eighths inch) is conveyed to the covered, prepared shale storage area. Shale fines (less than three-eighths inch) are transported by conveyor to the fines storage area.



PARAHO DEVELOPMENT CORP.
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FIGURE 2.5.3

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CLIENT: PARAHO DEVELOPMENT CORPORATION COMMERCIAL FEASIBILITY STUDY

Davy McKee ENGINEERS AND CONSTRUCTORS

TITLE: MATERIAL HANDLING SCREENING & TRANSFER STATION

SCALE: AS NOTED

5589A 0163 - SK11

REVISION 0

NO	DESCRIPTION
0	ISSUED FOR REPORT

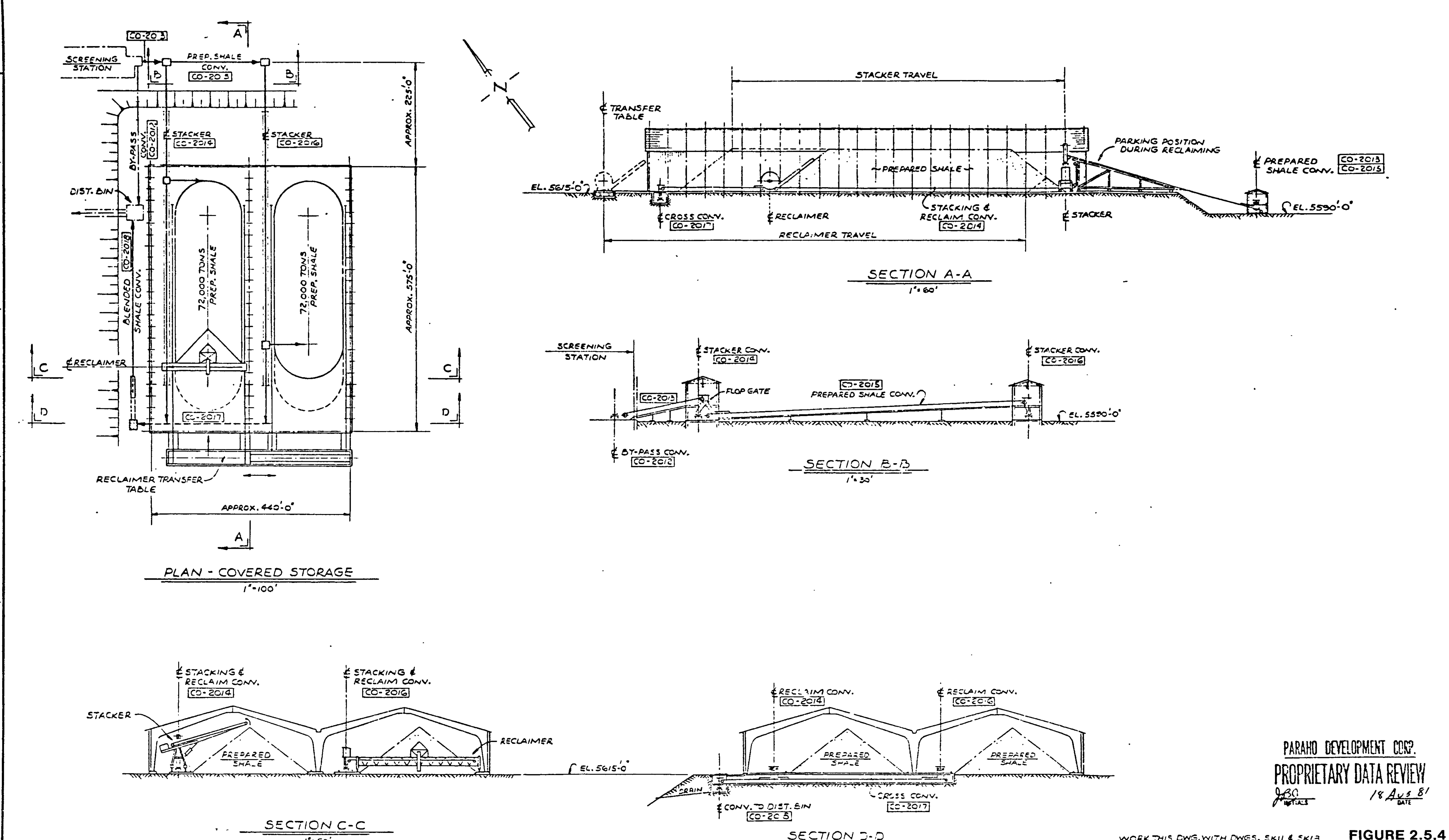

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FIGURE 2.5.4

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CLIENT: PARAHO DEVELOPMENT CORPORATION COMMERCIAL FEASIBILITY STUDY

Davy McKee ENGINEERS AND CONSTRUCTORS

TITLE: MATERIAL HANDLING COVERED STORAGE

SCALE: AS NOTED

5589A
0163-SK12

REVISION 0

NO.	DESCRIPTION	BY	CH.	APPROVED	DATE
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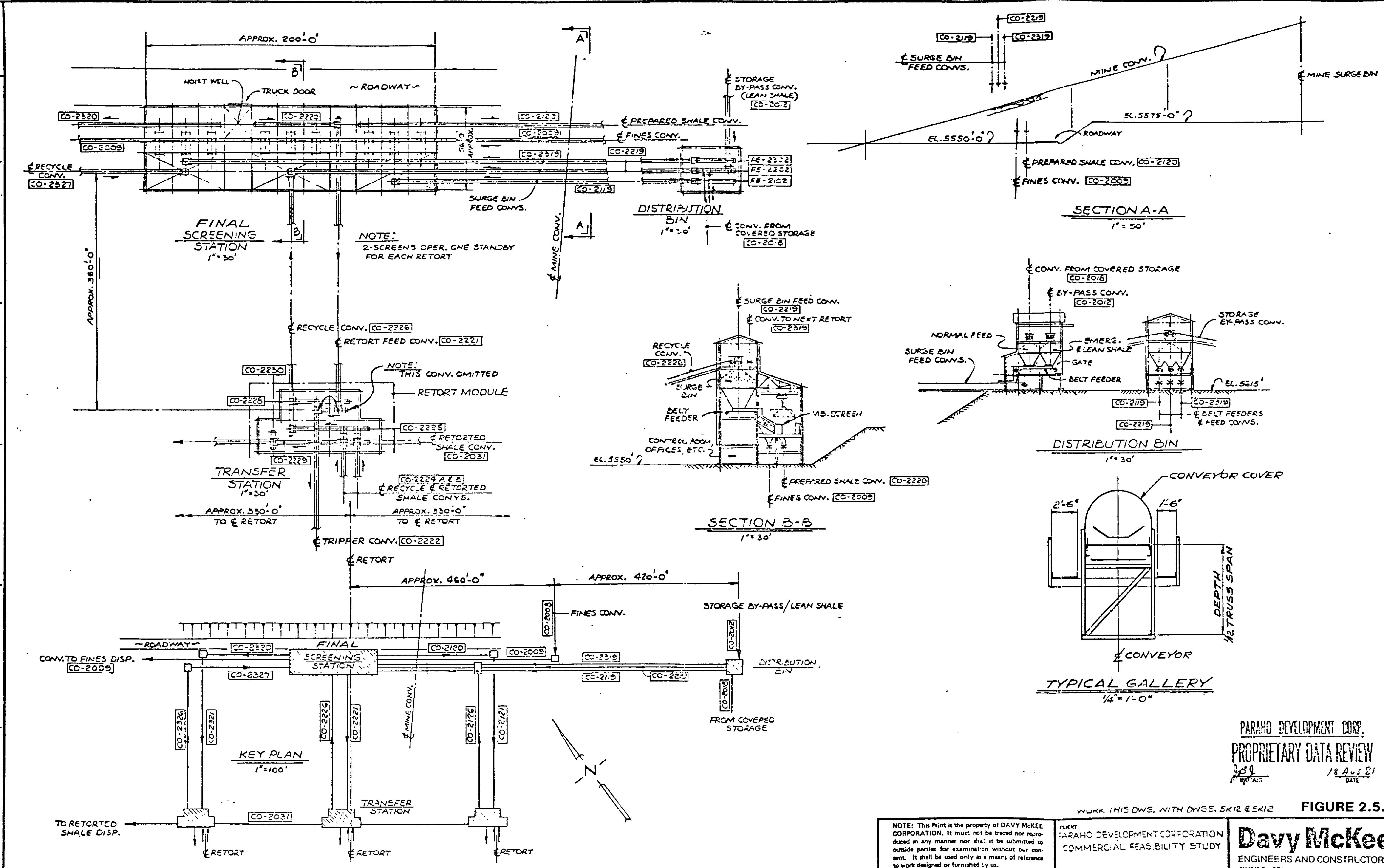

PARAHO DEVELOPMENT CORP.
PROPRIETARY DATA REVIEW
18 Aug 81

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FIGURE 2.5.5

CLIENT: PARAHO DEVELOPMENT CORPORATION COMMERCIAL FEASIBILITY STUDY

Davy McKee
ENGINEERS AND CONSTRUCTORS

TITLE: MATERIAL HANDLING SCREENING STATION & DISTRIBUTION BIN

SCALE: AS NOTED

5589A
0163 - SK13

REVISION 0

ISSUED FOR REPORT

The covered, prepared shale storage area (see Figure 2.5.4) has a capacity of two day's feed. A stacker feed system with a blender wheel reclaimer assures a feed of uniform shale quality to the retorts. A bypass system is also available to insure retort feed should mechanical problems arise in the covered storage area.

A distribution system breaks shale flow from blending into three identical streams, one for each retort module. Each identical stream is fed to an individual final screening area (see Figure 2.5.5). Each area consists of a dual operating train (and spare train) including surge bin, feeders, and vibrating screens. Retort feed material is separated and fed to the retort after weighing and sampling. Reject fines are conveyed to the fines storage area. The surge bins of this system also receive some shale feed from a recirculation conveyor from the retort. This conveyor handles overflow from the retort tripper conveyor as well as recirculated shale during start-up procedures.

Conveyors. All aboveground shale handling operations will be enclosed with the exception of the emergency storage piles. All major operations, such as blending, crushing, and screening will be housed in buildings (as illustrated in Figures 2.5.3, 2.5.4, and 2.5.5). All aboveground conveyors are fully hooded as illustrated in the sketch "Typical Gallery" in Figure 2.5.5. All transfer points are fully enclosed. Air drawn between the conveyor belt and hooded cover and from all transfer points is directed to dust suppression control devices. Baghouses are used for all raw shale dust suppression. Because the retorted shale system is equipped with water sprays for emergency temperature control, wet suppression is used to control emissions in that system.

2.5.3 Retorting

Operations. The retorting operations for the proposed action will be carried out using the Paraho retorts operating in the Direct Heat Mode. The three retorts will have independent shale feeding, screening, and sampling stations so that they can be operated independently. The overall retorting operation will require as much as 65,000 TPSD of raw shale feed. The three retorts will produce (per stream day) about 53,000 tons of retorted shale, 39,500 barrels of crude shale oil, 2,000 barrels of water separated from the oil, and 500 million standard cubic feet of product gas.

The Paraho Retort. The Paraho retort is a vertical kiln having a refractory-lined, carbon steel shell. A schematic flow diagram is presented in Figure 2.5.6. An isometric drawing of the Paraho commercial retort is pictured in Figure 2.5.7. The height of the structure housing this retort will be about 155 feet. Near the top of the retort is the off-gas collector where the oil mist and gas are removed from the retort. Below the off-gas collectors are gas/air distributors located at three separate levels in the retort. The bottom air/gas distributor is located above the grate mechanisms at the bottom of the retort. These grates are the only moving pieces within the retort.

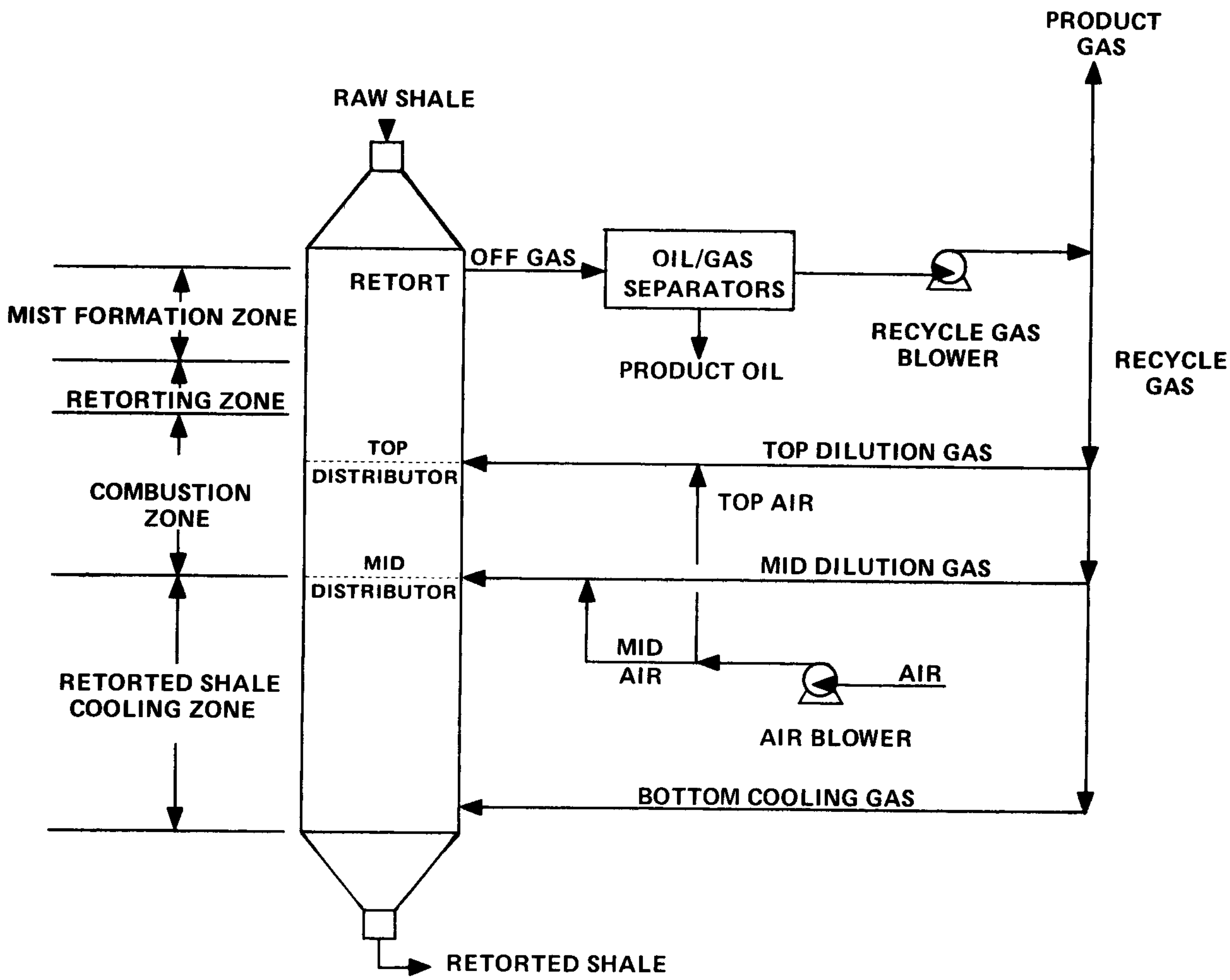
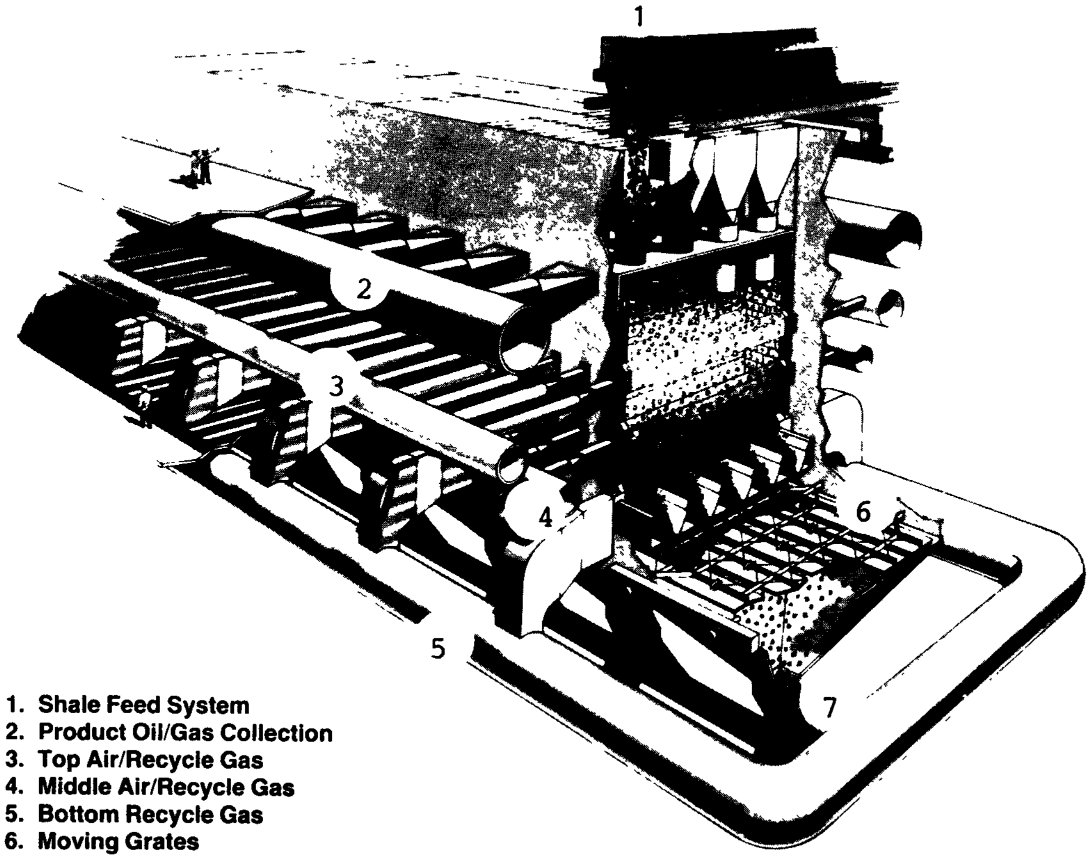


FIGURE 2.5.6

PARAHO
DIRECT HEATED
MODE



1. Shale Feed System
2. Product Oil/Gas Collection
3. Top Air/Recycle Gas
4. Middle Air/Recycle Gas
5. Bottom Recycle Gas
6. Moving Grates
7. Processed Shale
   to Reclamation

Paraho Commercial Module Retort
Paraho Development Corporation

FIGURE 2.5.7

<u>Direct Heat Mode</u>. In the Direct Heat Mode, internal combustion produces the heat for retorting. Other than for start up needs, no external fuel source is required. Raw shale enters the top of the retort and is preheated in the mist formation zone by the gases carrying the oil mist out of the retort. The preheated shale next enters the retorting zone where the hot gases rising from the internal combustion heats the shale to retorting temperature. Upon retorting, the solid organic kerogen in the shale breaks down to gas, oil, and coke. The gas and oil are swept upward with the hot gases while the coke remains on the retorted shale. As the retorted shale descends into the combustion zone, some of the coke is burned with the air introduced through the gas/air distributor. Only enough air is introduced to produce enough heat for the retorting process. Recycle gas is added with the air to insure even distribution across the bed and to control the flame temperature. Below the middle distributor, the retorted shale descends into the cooling zone where it is cooled by recycle gas rising from the bottom distributor. Both the gases (and oil mist) and retorted shale are relatively cool when they leave the retort. Thus, within the Paraho retort there are counter current flows with gases moving upward and shale moving downward under the force of gravity and controlled by the grate. These flows produce the hot combustion and retorting zones in the middle with heat exchange above and below. The results are that heat losses are low and energy efficiency is high.

2.5.4 Shale Oil Recovery and Upgrading

Shale Oil Recovery. Gas leaving the top of each retort, containing oil droplets in a fine mist, is collected in a header. The gas flows to the oil recovery area where it is split into four parallel streams, each to be handled in one of four systems including a knockout drum, coalescer, and electrostatic precipitator. This is the means by which the oil is separated from the gas and collected for further processing.

The oil-water is pumped to three oil-water separation tanks. A fourth tank is provided as a spare. These tanks are sized to hold the oil-water for 24 hours to gain effective separation of water from the shale oil. Each of these tanks has a 53,000 barrel capacity. The tanks are steam heated with external plate coils to keep the high pour point oil in a fluid state during cold weather. The water-free crude shale oil, approximately 39,500 BPSD, is pumped from the separation tanks to the intermediate storage tanks. Water from the separation tanks, about 2,000 BPSD, is pumped to the process wastewater treatment facility (see Section 2.5.6).

Shale Oil Upgrading. In order to transport the product oil by pipeline and reduce handling, storage, and marketing problems, the sulfur and nitrogen components of the shale oil must be substantially reduced and the pour point lowered to ease pumping requirements. Hydrotreating and adding a pour point depressant are the methods to be used to accomplish these objectives.

The initial step in upgrading is solids removal. The crude shale oil is pumped through filters where about 64 tons/day of oil filter materials will be removed from the oil. The oil filter solids are transported for off-site reclamation. The oil is passed through an arsenic guard bed prior to hydrotreating.

During hydrotreating, the oil is reacted with hydrogen from the hydrogen reformer. Sulfur and nitrogen present in the oil are converted to hydrogen sulfide and ammonia. The effluent from the hydrotreater reactor is composed of three streams: a sour water stream containing the hydrogen sulfide and ammonia is sent to the sour water treatment unit; a gas stream composed primarily of hydrogen is removed and recycled; an oil stream proceeds to final processing.

In the final processing, the oil is sent to the hydrogen sulfide stripper. The effluent from the hydrogen sulfide stripper is composed of two streams. A gas stream that is sent to the Stretford units for sulfur removal, and the final oil stream. Properties of the hydrotreated shale oil are listed along with the crude shale oil in Table 2.5.1.

The pour point depressant is injected into the oil after leaving the hydrotreating area. After the injection of pour point depressant, the oil proceeds to storage before being pipelined to market.

Paraho

TABLE 2.5.1

PARAHO CRUDE AND HYDROTREATED

SHALE OIL PROPERTIES

	Crude Shale Oil (1)	Hydrotreated Shale Oil (2)
Density at 60°F	0.929	0.861
Viscosity		
cSt @ 40°C	40.8	6.3
cSt @ 100°C	5.4	2.0
Pour Point - °F	85.0	85.0
Carbon, Wt%	84.8	86.6
Nitrogen, Wt%	2.0	0.1
Hydrogen, Wt%	11.4	13.1
Sulfur, Wt%	0.6	0.0001
Water, Wt%	0.3	NA
Sediment - ml/100G	0.1	0.02

(1) Heistand et al 1980.
(2) Sullivan and Strangeland. 1978.

2.5.5 Gas Clean-up and Utilization

In the retorting, hydrotreating, and wastewater treatment processes, a total of approximately 500 million SCFD of off-gas will be produced. The proposed end use of this off-gas will be process fuel for the hydrotreater and on-site cogeneration of electrical power. Typical off-gas composition from the Paraho retorting process before clean-up is presented in Table 2.5.2.

Off-Gas Cleanup. In order to reduce SO_2 and NO_x emissions during the utilization of the off-gas, it will first be circulated through an off-gas cleanup system. The gas cleanup area includes ammonia scrubbing, Stretford desulfurization and a sour water treatment unit. The ammonia scrubbing system removes the ammonia from the retort product gas with a water wash. Stretford desulfurization is used to remove hydrogen sulfide from the retort product gas streams and the hydrotreater off-gas. This method is effective in removing hydrogen sulfide from gases. The sour water treatment system removes hydrogen sulfide and ammonia from water streams coming from the ammonia scrubbing section, hydrotreater, and retorts. The unit separates the water, ammonia, and hydrogen sulfide (acid gas) into individual streams.

Ammonia Scrubbing. Off-gas from the retorts is initially compressed before it flows to the ammonia absorber. As the gas moves upward in the ammonia absorber, nearly all of the ammonia, plus some carbon monoxide and hydrogen sulfide, is absorbed by water. This

TABLE 2.5.2

TYPICAL[1] COMPOSITION OF PRODUCT OFF-GAS

Constituents	Vol. %
H_2	5.5
N_2	61.0
O_2	0.0
CO	2.9
CH_4	2.4
CO_2	24.2
C_2H_4	0.7
C_2H_6	0.6
C_3	0.6
C_4	0.6
C_5+	0.6
H_2S	0.3
NH_3	0.6
Total	100.0

(1) Jones and Heistand 1979

water is pumped to the sour water treatment unit. The ammonia-free gas then flows to the Stretford units for H_2S removal. The ammonia concentration of the retort off-gas is initially about 5,000 ppm. After ammonia scrubbing, the ammonia concentration will be reduced to about 165 ppm. A total of approximately 1,200 lbs/hr of ammonia is removed from each retort's gas stream (Paraho 1982).

Stretford Desulfurization. The Stretford cleanup system will utilize seven units. Six are dedicated to treating the combined gas flow from the retorts and the sour water treatment unit. The H_2S composition of the combined flow is approximately 4,500 ppmv. The gas stream from the hydrotreater is treated in the seventh Stretford unit. The H_2S concentration of this gas is about 30,000 ppmv. Total sulfur recovery from the Stretford desulfurization process will be 95 TPSD (Paraho 1982).

The gas containing H_2S is fed to the Stretford absorber tower where more than 99% of the H_2S is absorbed in the Stretford solution. The sulfur-rich Stretford solution then enters the reaction vessel where a reduction-oxidization reaction takes place. The results of this reaction are reoxidized Stretford solution that is pumped back to the absorber tower and sulfur. The sulfur is melted and crystalized before disposal.

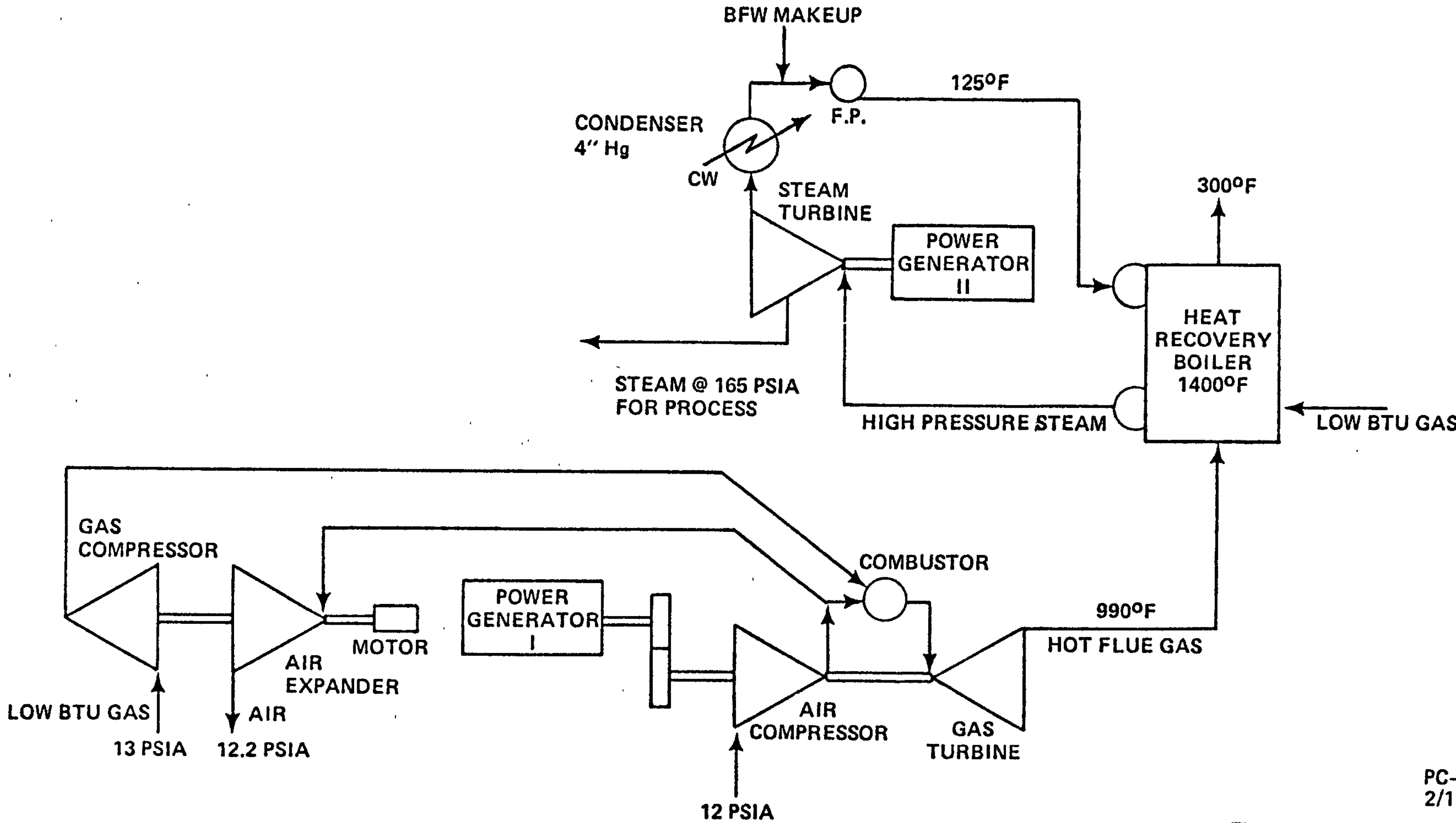
Sour Water Treatment. The major feed to this unit is the ammonia-rich water from the ammonia scrubbing unit. A preconcentrator tower produces a stripped water stream and a hydrogen sulfide and ammonia-rich water stream. The latter stream, along with condensed water from the ammonia scrubbing and the hydrotreater wash water, is sent to the hydrogen sulfide stripper. Hydrogen sulfide and carbon dioxide are removed in one stream, mixed with retort off-gas and sent to the Stretford units. Ammonia is stripped from another stream in an ammonia stripping column, compressed, and condensed to a salable anhydrous ammonia. The stripped water from the ammonia stripping column is mixed with the stripped water from the pre-concentrator tower and is recycled to the hydrotreaters, ammonia scrubbing units, and the wastewater treatment plant.

Gas Utilization. The conceptual design of product gas utilization, after gas clean-up, is shown in Figure 2.5.8. Approximately 385 million SCFD of clean gas, representing about 2.11 billion Btu/hr, will be available as fuel for power generation. The retort's off-gas will make up about 97% of the total, the remaining 3% coming from the wastewater treatment. The heating values of this off-gas is approximately 130 Btu/SCF. Power generation is accomplished with gas turbine/steam turbine cogeneration technology (Paraho 1982).

The estimated gross power output will be 185 MW at 13.8 kv plus 187,500 lb/hr of steam at 165 psia for process use. It is estimated that the peak electrical need for the Paraho-Ute facility will be 155 MW. Thus, about 30 MW of electrical power will be available for marketing.

Figure 2.5.8

PARAHO
PRODUCT GAS UTILIZATION
CONCEPTUAL DESIGN



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2.5.6 Water Treatment

There are two major water streams that will require treatment: raw (river) water and wastewater. This section discusses the treatment systems to be used for each stream.

Raw (River) Water Treatment. The river water treatment system provides makeup water for the process cooling tower, boiler feed, and potable water systems. Each of these require different levels of treatment. The system is designed to meet all three requirements.

Raw water will initially be clarified and softened in a reactor clarifier using lime for softening the water and coagulating the solids.

The pH of the clarifier effluent will be adjusted before it passes through pressurized sand filters. After filtration, about two-thirds of the effluent will be used in the cooling tower makeup. The remaining effluent from the sand filters will pass through activated carbon filters.

The effluent from the activated carbon unit will be directed to the boiler feedwater treatment. The boiler feedwater will be treated by strong acid cation exchangers, followed by a degasifier, weak and strong base anion exchangers and a mixed bed exchanger that completes the treatment.

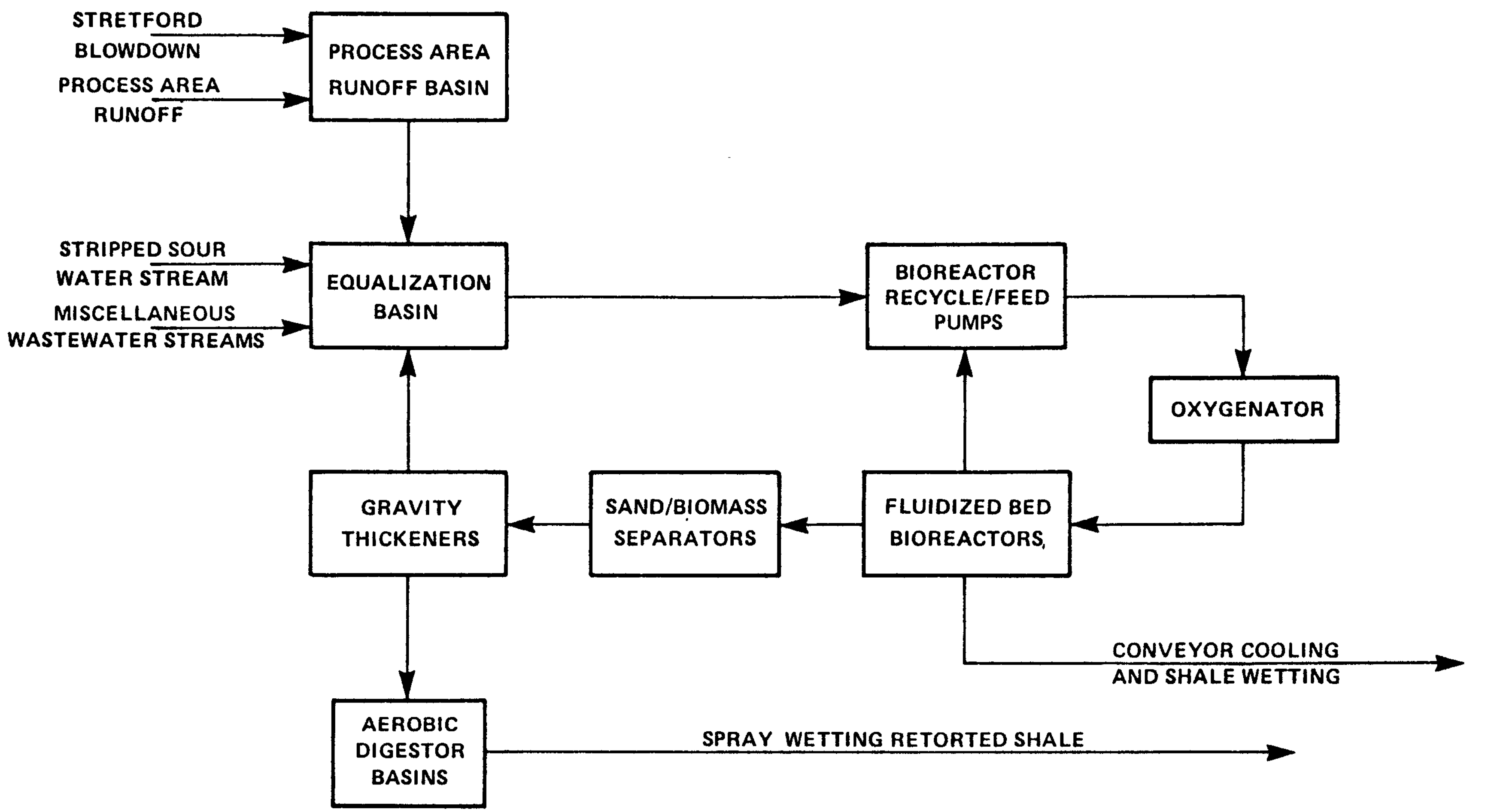
The potable water fraction will be drawn from the reactor clarifier effluent to pass through a break tank in order to separate it from the other water streams. Water leaving the break tank will be treated with activated carbon, then passed through a gravity filter, chlorinated, and finally pumped to storage tanks for use.

Wastewater Treatment. Wastewater treatment consists of three treatment systems, each designed to treat one of the three following wastewater streams: process wastewater, inorganic wastewater, and sanitary wastewater.

Process Wastewater Treatment. The major feed to this treatment is stripped water from sour water treatment (refer to Section 2.5.5). Additional feed consists of process area surface runoff, retort service wastewater, and condensate from steam users. A simplified block flow diagram of the process wastewater treatment system is provided in Figure 2.5.9.

The combined waters are initially mixed in an equalization basin. It then is oxygenated before proceeding to the biological treatment system, consisting of fluidized bed reactors.

Effluent from the biological treatment system flows to a retention pond. Water stored in this pond is used for retorted shale disposal conveyor cooling and lubrication and for spray wetting during storage and disposal of raw shale fines and retorted shale.



PROCESS WASTEWATER TREATMENT SYSTEM

FLOW DIAGRAM

FIGURE 2.5.9

Biomass from the biological treatment system will be separated from the fluidized bed reactor growth media in sand/biomass separators. The growth media is recycled to the reactors. The resultant sludge is thickened in gravity thickeners and stabilized in aerobic digestor basins.

Inorganic Wastewater Treatment. The feed to this system is made up of boiler blowdown, treated sanitary wastewater, and backwash from the raw water treatment filter: These streams are combined, treated by chemical precipitation and coagulation for the removal of hardness, and filtered. The effluent from this system is used as make-up water for the cooling tower.

Sanitary Wastewater Treatment. Two sanitary wastewater treatment units are incorporated into the project design. One will be used in handling all of the mine requirements, while the other will be used to treat the surface facility sanitary wastewaters. Each will be a package sewage treatment plant. Biodegraded sludges from the sanitary wastewater treatment plants, raw water treatment plant, and process wastewater treatment unit will be applied to the retorted shale during shale disposal.

2.5.7 By-Product Handling

The Paraho-Ute operations will produce three major by-products: electricity, ammonia, and sulfur.

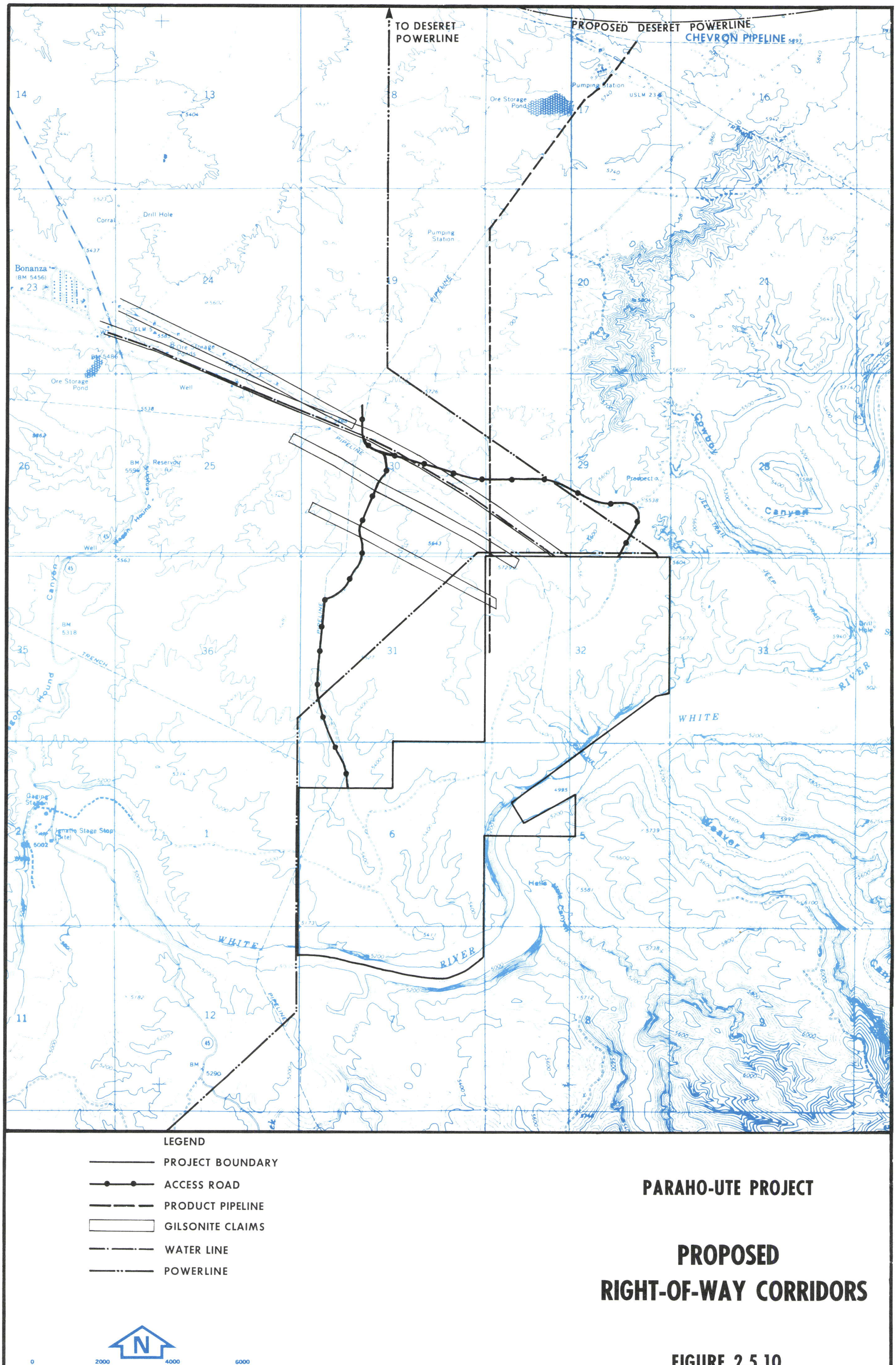
Electricity. Electricity is produced by burning the cleaned, low Btu off-gas in gas combustion turbines and in waste heat boilers driving steam turbines (as described in Section 2.5.5). Total power production will be approximately 185 MW. Power generated will be used to operate the plant with the excess, about 30 MW, to be sold. Paraho plans to qualify as a cogenerator and thus would be able to sell electricity to the Deseret Generation and Transmission Cooperative.

Ammonia. All the ammonia from the ammonia scrubbing unit and the hydrotreating units will be recovered in the anhydrous form using a sour water treatment unit. The ammonia will be stored in an atmospheric pressure, refrigerated storage facility before transport by tank trucks to market. The ammonia will be produced at about 210 TPSD.

Sulfur. Sources of sulfur are H_2S contained in the retort product gas, H_2S from various sour water streams, and H_2S converted from sulfur compounds in crude shale oil when it is up-graded in the hydrotreaters. Gas streams containing these sources of H_2S are processed in the Stretford units to recover approximately 95 TPSD of elemental sulfur. It will be disposed as a dry cake with the retorted shale.

2.5.8 Off-Site Facilities and Rights-of-Way

Rights-of-way and off-site corridors required for the Paraho-Ute Project are shown in Figure 2.5.10. The off-site facilities and rights-of-way are needed for water coming into the project, roads to and from the site, power to and from the project, and the product



SOURCE: USGS 7½ MIN. QUADS, SOUTHAM CANYON, UTAH, WEAVER RIDGE, UTAH, BONANZA, UTAH, WALSH KNOLLS, UTAH

PARAHO-UTE PROJECT

PROPOSED RIGHT-OF-WAY CORRIDORS

FIGURE 2.5.10

JUN 1982

pipeline from the project. The acreage required and land status of the off-sites and rights-of-way were provided in Section 2.2.

Water will be piped to the site in a pipeline to be built during an initial stage of construction. This new pipeline will be built along gilsonite claims (private land) from Bonanza to the northwest corner of the project site on Section 32. It will be approximately 2-1/2 miles long and will disturb approximately 30 acres of land. No Federal right-of-way permit is needed since this proposed access would cross no federal lands. (Refer to Section 4.3.2 for alternative water sources and related off-site facilities and rights-of-way.)

The two existing roads that access the project site from the north will be upgraded and paved. The majority of equipment and project materials will use the main access road that enters the project site along the north edge of Section 32. The road that enters the project on the north edge of Section 6 will be used primarily for workforce access to the construction camp. Because these two roads cross Federal land, rights-of-way permits from the BLM are required before these roads can be upgraded. A right-of-way permit application for the main access road is pending. Applications for rights-of-way permits for the second road will be filed later in 1982.

Moon Lake Electric is planning to build a loop-line to serve several synfuels projects and the White River Dam with electric power. Power for the Paraho-Ute Project will come from this loop-line. The design, construction, and right-of-way for the loop-line will be done by Moon Lake Electric. Paraho will export excess power along this same loop-line.

The hydrotreated shale oil will be piped through a new pipeline which Paraho will construct. The new pipeline will leave Section 32, proceed north for approximately 3-1/2 miles, and connect with the existing Chevron pipeline on Section 17 (T9S, R25E). A right-of-way permit application for the new pipeline, which will cross and disturb approximately 40 acres of Federal land, is pending.

2.5.9 Storage Tanks

Day Tanks. The Paraho-Ute facility will have four day tanks. Shale oil from the oil recovery section will flow to the day tanks, where the oil will be heated to enhance water removal. Each tank will have a covered floating roof (i.e. internal floating roof) with a single seal system. The tanks will be about 115 feet in diameter and about 30 feet high and have a nominal capacity of 53,000 barrels each.

Crude Shale Oil Storage Tanks. The crude shale oil will be pumped from the day tanks to intermediate tankage before hydrotreating. Seven storage tanks are available. Each tank will have a diameter of about 150 feet and have a capacity of 150,000 barrels. The tanks will be fitted with floating roofs and have both primary and secondary seals.

Hydrotreated Shale Oil Storage Tanks. After hydrotreating, the oil will be stored in two 150,000 barrel storage tanks prior to shipment via pipeline. Each tank will be about 150 feet in diameter and have a floating roof with primary and secondary seals. Heating is required to keep the oil in a fluid state during cold weather. (Pour point depressant will be added prior to storage.)

Other Storage Tanks. No. 2 fuel oil, propane, diesel fuel, and gasoline will also be stored on-site. No. 2 fuel oil will be stored in one 13,500 bbl storage tank and two 11,250-gallon day tanks. These tanks will have fixed roofs and vent to the atmosphere.

The storage of propane, to be used as needed as a backup for natural gas, will be by one cryogenic tank with a capacity of 52,000 barrels. The propane that will be used for the flare pilot will be stored separately in two pressurized tanks having a capacity of 21,500 gallons each.

The remaining storage tanks will either be in the mine or buried. Plans call for the following storage tanks:

- 60,000 gallon diesel fuel tank
- 5,000 gallon diesel fuel tank
- two 2,000 gallon diesel fuel tanks
- 20,000 gallon diesel fuel tank
- 20,000 gallon gasoline tank
- 2,000 gallon gasoline tank

2.5.10 Emissions, Effluents, and Solid Wastes

The construction and operation of the Paraho-Ute facility will produce gas, liquid, and solid waste streams. Many of these streams will require treatment before they may be discharged into the environment. For example, the off-gas will be desulfurized to limit sulfur emissions. Water will be used, treated, and reused for dust control and retorted shale moisturizing, or evaporated so that the wastewater discharge rate will be zero.

Air Emissions. The Paraho-Ute facility will consist of six major areas of activities that will contribute to air emissions. These areas are as follows: 1) below ground activities, 2) shale handling activities, 3) solid materials storage activities, 4) activities from gas combustion processes, 5) oil and fuel storage, and 6) retorting.

The emissions from all project sources will be controlled using best available control technology. Emissions will be in compliance with the Utah Air Conservation Regulations requirements. A Prevention of Significant Deterioration (PSD) permit, which is part of an Approval Order to Construct and Operate Sources of Air Pollution, must be issued by the State of Utah Air Conservation Committee before construction begins. Complete details of the project's impact on air quality are provided in Paraho PSD permit application (Pforzheimer 1981).

The management of air quality will be concerned primarily with the following four major pollutants: 1) total suspended particulates (TSP), 2) sulfur dioxide (SO_2), 3) oxides of nitrogen (NO_x), and 4) hydrocarbons (HC).

Table 2.5.3 presents the sources, emissions before control, control measures, and controlled emissions of TSP from the project during operations. The major sources of TSP will be from mining and shale handling activities. The control measures will effect a 98% reduction of TSP before it enters the environment.

Table 2.5.4 presents the sources, emissions before control, control measures, and controlled emissions of SO_2 from the project during operations. The major source of SO_2 will be from the product gas clean-up and combustion processes. The control measures will effect a 97% reduction of sulfur pollutants before they enter the atmosphere.

Table 2.5.5 presents the NO_x emissions information for the project during operations. The product gas clean-up and combustion processes will be the major source of NO_x. The control measures will reduce the emissions by 93%.

Table 2.5.6 provides the emissions information for HC. The major source of HC emissions will result from the storage of oil and fuels. Since the emissions before control are not available, the control efficiency cannot be calculated.

Table 2.5.3
Emissions Summary for
Total Suspended Particulates (TSP)

Activity	Emissions Before Control Measures (Tons/Yr)	Control Measures	Controlled Emission (Tons/yr)
1. Below ground; mining, blasting transfers, crushing and equipment	18,101	Wet Suppression, Baffled Settling, and Baghouses	164
2. Above-ground Shale Handling; transfers, crushing, screening, and retort discharge	60,032	Baghouses and Wet Scrubbers	379
3. Retorts	Negligible	N/A	Negligible
4. Solids Storage/Disposal; surficial soils, overburden, shale fines, retorted shale	1228	Enclosed Buildings, Water sprays, Wet Suppression, and Vegetative Cover	170
5. Gas Combustion; hydrogen plant and hydrotreater furnaces, power generation, and package boiler	195	None	195
6. Oil and Fuel Storage	None	N/A	None
			Control Efficiency 98%

N/A:Not Applicable
Source: PSD Permit Application (Pforzheimer 1981).

Table 2.5.4
Emissions Summary for

Sulfur Dioxide (SO_2)

Activity	Emissions Before Control Measures (T/Y)	Control Measures	Controlled Emissions (T/Y)
1. Below-ground; mobile equipment	66	None	66
2. Shale Handling	None	N/A	None
3. Retorts	Negligible	N/A	Negligible
4. Solids Storage/Disposal	None	N/A	None
5. Gas Combustion; hydrogen plant and hydrotreater furnaces, power generation, and package boiler	65,545	Stretford	1642
6. Oil and Fuel Storage	None	N/A	None
			Control Efficiency 97%

Source: PSD Permit Application (Pforzheimer 1981).

Table 2.5.5
Emissions Summary for
Oxides of Nitrogen (NO_x)

Activity	Emissions Before Control Measures (T/Y)	Control Measures	Controlled Emissions (T/Y)
1. Below-ground; mining blasting, equipment	932	Catalytic Converters	840
2. Above-ground Shale Handling	None	N/A	None
3. Retorts	Negligible	N/A	Negligible
4. Solids Storage/ Disposal	None	N/A	None
5. Gas Combustion; furnaces, power generation, and package boiler	54,355	Low NO_x Burners, Water wash	2837
6. Oil and Fuel Storage	None	N/A	None
			Control Efficiency 93%

Source: PSD Permit Application (Pforzheimer 1981).

Table 2.5.6
Emissions Summary for
Hydrocarbons (HC)

Activity	Emissions Before Control Measures (T/Y)	Control Measures	Controlled Emissions (T/Y)
1. Below-ground; mining, mobile equipment	60	Catalytic Converters	6
2. Shale Handling	None	N/A	None
3. Retorts	Negligible	N/A	Negligible
4. Solids Storage/ Disposal	None	N/A	None
5. Gas Combustion; furnaces, power generation, package boiler	39	None	39
6. Oil and Fuel Storage	Not Available	Floating Roofs, Primary and Secondary Seals, Seals, Valves, Pumps	9

Source: PSD Permit Application (Pforzheimer 1981).

The overall efficiency of the control measures that Paraho will use will reduce the emissions by about 96%. All control equipment will be tested and maintained in accordance with the Utah Air Conservation requirements.

(The baseline air quality conditions are presented in the Appendix, Section 5.1).

Effluents. The project will be a zero wastewater discharge facility. All treated wastewater from the facility will be evaporated or reused for such purposes as cooling tower makeup, processed shale disposal/storage moisturizing, dust control, and fire protection. All contaminated runoff from the plant process area will be collected and treated with the process wastewater. The contaminated runoff collection system and associated wastewater retention pond are designed to contain runoff from a 100-year, 24-hour precipitation event. All possible contaminated runoff from the retorted shale disposal embankment (refer to Figure 2.1.4) will be collected in retention ponds designed to contain the 100-year, 24-hour storm runoff.

Paraho has applied to the EPA for a National Pollutant Discharge Elimination System (NPDES) permit (Lukens 1982). The Paraho-Ute facility will operate in compliance with the NPDES permit. The only effluents from the project will be uncontaminated precipitation runoff. These will be diverted away from the facility process areas and the processed shale disposal and storage areas, and directed to the drainages that flow towards the White River.

Solid Wastes. The facilities to be used for the disposal of solid wastes generated during the construction and operation of the Paraho-Ute Project will be in compliance with the regulations of the Utah Bureau of Solid Waste Management and permitted in the plan approval of the disposal facilities (Lukens 1982).

The solid wastes generated during operations are listed in Table 2.5.7. Retorted shale will be the larges in volume solid waste to be handled. Shale fines are not considered as a solid waste, as their ultimate use for shale oil recovery is being planned (see Section 4.1).

- Retorted shale disposal - A large retorted shale disposal area will be located in the dry canyon on Section 6, as shown in Figure 2.1.4. This disposal area has a capacity of approximately 110 million cubic yards. The disposal pile will be constructed to a peak elevation of approximately 5,600 feet.

  A low permeability lining will be constructed over the area to be occupied by the retorted shale. This liner will consist of retorted shale compacted at optimum moisture to provide permeability rates on the order of 0.1 to 1.0 feet per year ($1x10^{-7}$ to $1x10^{-6}$ cm/sec). A retaining embankment to surround the disposal area will be constructed of retorted shale compacted to a high

TABLE 2.5.7

SOLID WASTE QUANTITIES AND DISPOSITION

Method of Disposal	Solid Waste	Quantity & Design Case Rates
A. On-site Landfill	Construction Debris and Garbage	16,000 cu yd (first 3 years)
B. Raw Shale Fines Storage (temporary)	Raw Shale Fines	7,385 TPSD (max)
C. Retorted Shale Disposal Area	Retorted Shale	53,235 TPSD
	Wastewater Treatment Sludge	2,468 TPSD (wet basis, 0.6% solids)
	Sulfur, Crystalline Cake	95 TPSD
	Scrap and Garbage	4.6 T/D
D. Other		
Reclamation	Oil Filter Particles	64 TPSD (50% oil)
	ZnO Catalyst	250 cu ft/6 mo
	Lo-temp CO Shift Catalyst	2,600 cu ft/2 yr
	Methanator Catalyst	600 cu ft/2 yr
	Reformer Catalyst	1,500 cu ft/2 yr
	Hydrotreater Catalyst (ICR-106)	(Confidential)
Off-site Hazardous Waste	API Separator Bottoms	0.9 T/D
	Air Floatation Unit Float	0.09 T/D
	High-temp CO Shift Catalyst	1,750 cu ft/2 yr
	Arsenic Guard Bed Catalyst	9,600 cu ft/ 6 mo

Paraho 1982.

density without moisturizing (except for dust control). This embankment will be covered on its outer face with heavily compacted and moistened retorted shale similar to that of the lining. Natural rock riprap will be used as a final cover to protect the outer slopes from erosion. Retorted shale will be disposed within this embankment with compaction occurring through the controlled routing of hauling equipment and moistening limited to dust control.

Benches will be provided at 200 to 300-foot elevation intervals on the embankment. This will enhance slope stability by reducing the overall slope of the disposal pile embankments. Benches also provide a means of collecting and beneficially using or evaporating runoff waters. Runoff water from portions of the disposal pile below these benches will be controlled by a series of channels and collection and retention structures designed to prevent discharge to the White River from the 100-year, 24-hour storm. The downstream toe of the collection-evaporation pond embankment in the southeast corner of the disposal area will be above the maximum water level (elevation 5,023) of the White River Reservoir. The downstream toe of the disposal pile will also be above the anticipated water levels in that collection-evaporation pond.

- Other solid wastes - Design quantities and methods for disposal of other solid wastes generated during project operations are also listed in Table 2.5.7. Other solid wastes include wastewater treatment and pre-treatment lime sludges, oil filter particles, sulfur, garbage and scrap, and spent catalysts.

  It is anticipated that some hazardous wastes will be generated during the project operation. However, Paraho does not plan to treat, store, or dispose of any hazardous waste on-site. Rather, all hazardous wastes will be transported off-site by an approved carrier. Paraho has filed a Notification of Hazardous Waste Activity with the Utah Bureau of Solid Waste Management for the generation of hazardous wastes.

2.6 Design, Construction and Operating Features for Preventing and Minimizing Shale Oil Spills

Under state and federal regulations, a Spill Prevention, Control and Countermeasure (SPCC) Plan is not required until six months after a facility has come into operation. However, the basics for such a plan must be developed prior to operation. In fact, certain preventive measures are being incorporated into the facility design.

The following subsection briefly describes the design, construction and operating features for preventing and minimizing oil spills.

2.6.1 Spill Control

Spills may occur at the facility for a number of reasons. Examples of these are line breaks, fires, explosions and operator errors. Plant site areas where leaks may occur include, but may not be limited to, fuel-oil storage, shale-oil storage, retorting, oil-gas separation, product upgrading, wastewater treatment, and other areas involving the transfer and storage of oily substances.

Design features and procedures are and will be included to minimize the risks of such spills. Facilities identified as having a potential for spills are surrounded by berms. Storage tanks are located in diked areas. Secondary containment of spilled material is provided by several runoff storage ponds. Alarms are included to warn of potential overfill of storage tanks. During operation, routine inspections will be conducted to check for leaks. The facility will also have an adequate supply of spill containment and clean-up materials such as booms, sorbents, and skimming equipment.

A complete and thorough SPCC Plan will be developed. All applicable state and federal regulations will be followed in the development of this plan. The plan will be kept on file in the plant offices for inspection by EPA officials.

References

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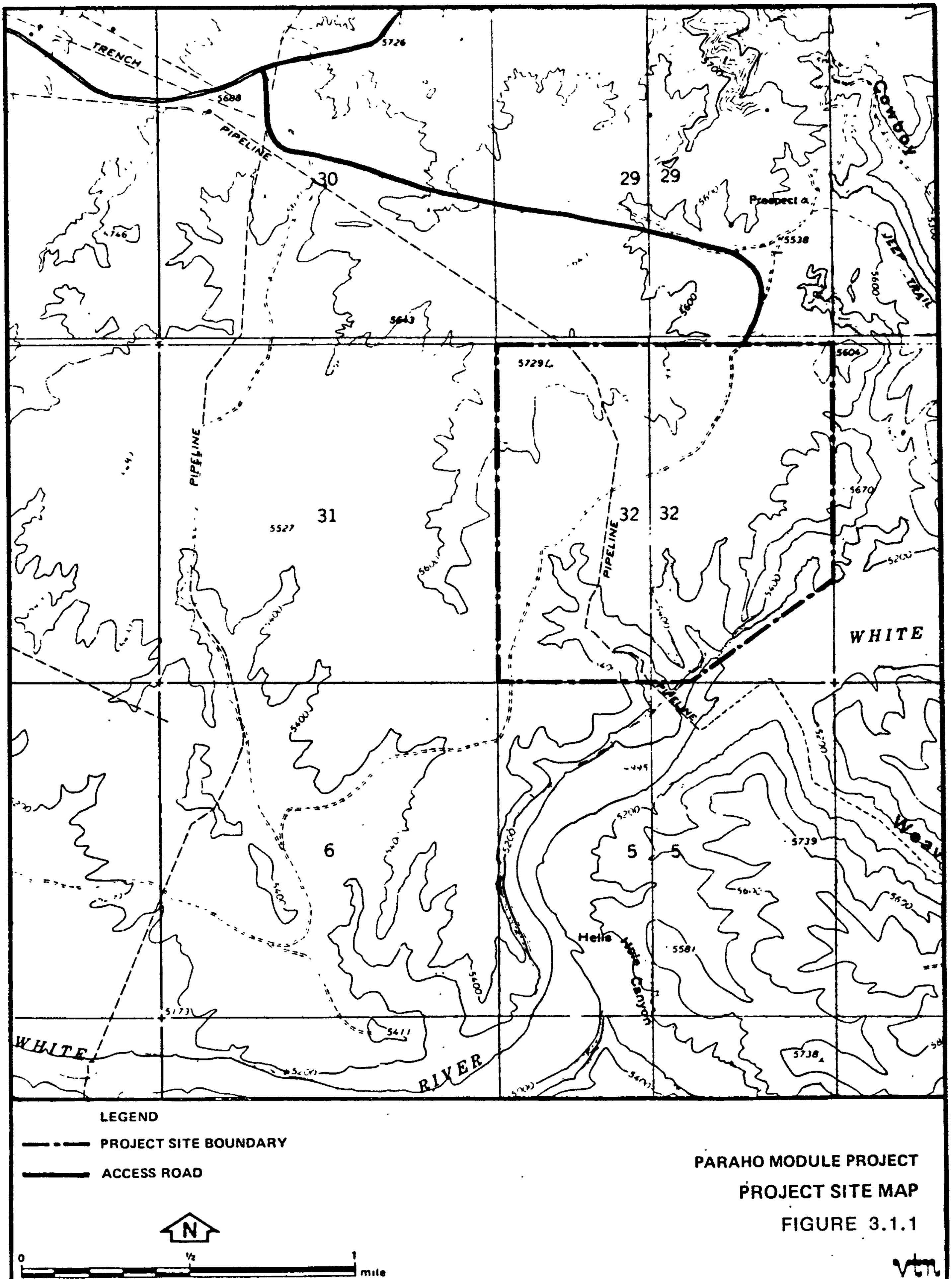
3.0 LOW LEVEL SCENARIO - SINGLE RETORT OPERATION

In connection with the preparation of the UBS-EIS, the Bureau of Land Management requested the individual participants to submit a low level commercial scenario as an Alternative Action (Edwards 1981). Paraho submitted a Single Retort Operation as an alternative with the understanding that it, in itself, does not constitute a "commercial scenario". Because a single retort operation would be essentially a large-scale research operation, it cannot be operated indefinitely. After a short operation, not to exceed two years, the Single Retort Operation would be either (a) scaled up to full commercial operation (the Paraho-Ute Shale Oil Facility); (b) abandoned; or, possibly (c) continued as a research facility. Details of the Single Retort Operation, a low-level alternative, are presented below.

3.1 General Project Description

Overall, the Single Retort Operation and the HIGH LEVEL SCENARIO are identical in most aspects. The differences are described below.

The Single Retort facility is approximately one-third the size of the high level facility. The Single Retort Operation will be located on the 582-acre Utah State Oil Shale Lease, Section 32, Township 9 South, Range 25 East, SLM. A map of the site location is provided in Figure 3.1.1.



PARAHO MODULE PROJECT

PROJECT SITE MAP

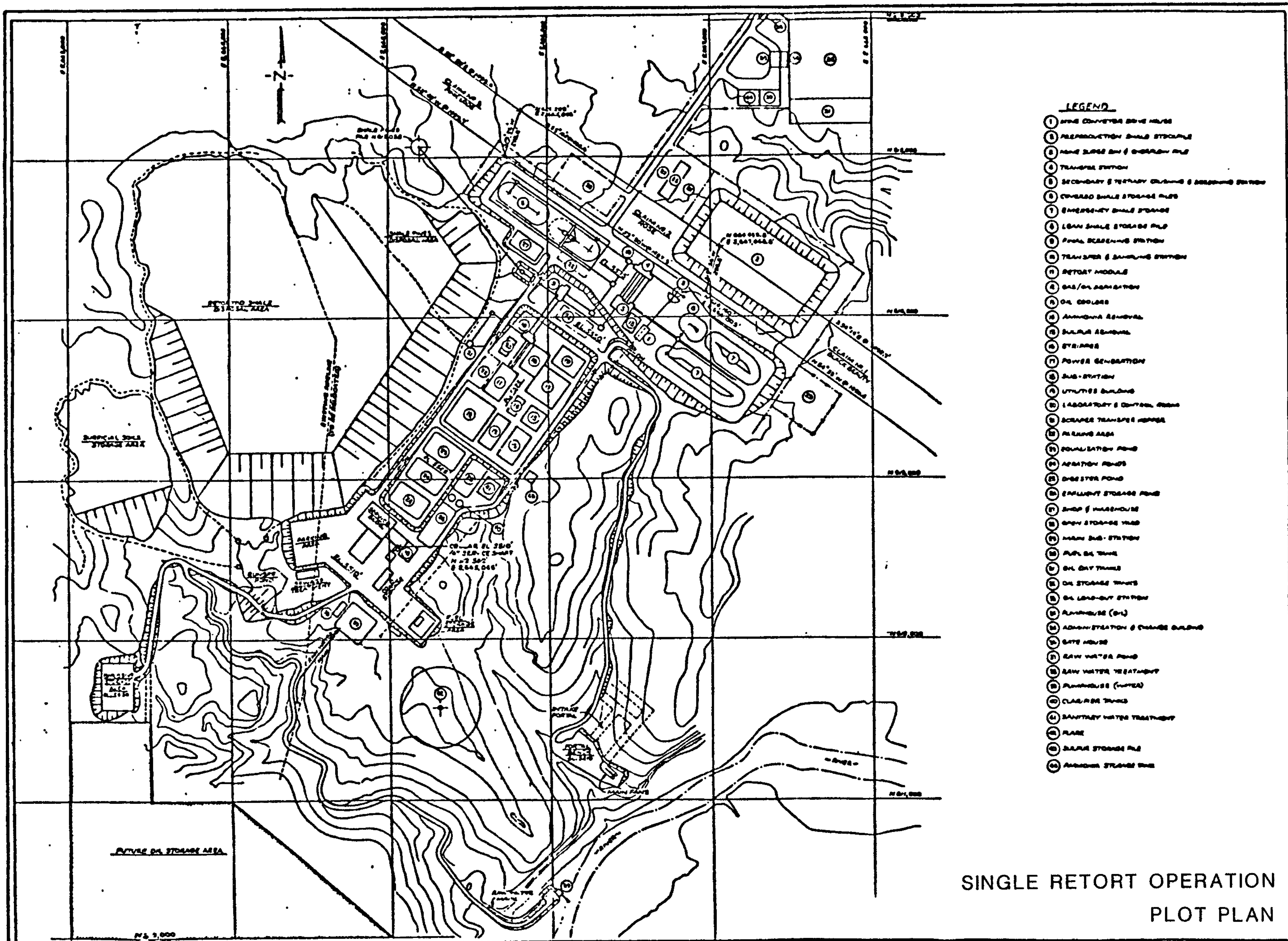
FIGURE 3.1.1

The process and project components are identical to those described in the HIGH LEVEL SCENARIO except for oil upgrading and distribution, electrical power generation, and the length of time of the project. The Single Retort Operation will not have oil upgrading nor electric power generation facilities. The construction will begin in early 1983 and last approximately 42 months. Operation of the single retort will begin in 1985 and last through 1988. At that time, the plans call for abandonment and reclamation of the facility. As indicated, all other mining, operation, and reclamation procedures are identical to those described in Section 2.0.

The Single Retort facility will produce up to 10,520 BPSD of crude shale oil. This will require a retort feed of up to 17,730 TPSD of crushed oil shale. The mine will produce up to 19,700 TPSD of oil shale (Paraho 1981).

Figure 3.1.2 shows the conceptual plot plans for the Single Retort Operation. Retorted shale and raw oil shale fines will be conveyed to a disposal site near the plant facilities within the 582-acre lease tract. Up to 14,400 TPSD of retorted shale and 1,970 TPSD of raw shale fines will be conveyed to the disposal site.

Product oil will be sent to product storage tanks with two years production capacity (about 6 million barrels).



SINGLE RETORT OPERATION
PLOT PLAN

FIGURE 3.1.2

Source: Paraho 1981.

3.2 Resource Requirements

3.2.1 Land Acreage Requirements and Status

A breakdown of the land acreage requirements and status, by project component, is presented in Table 3.2.1. Off-site rights-of-way acreage requirements are also presented in this table. The acreage requirements provided in this table are estimates based on conceptual plot plans (Paraho 1981).

3.2.2 Water

The overall water demand will be approximately 528 gpm. Water will be produced during retorting at a rate of about 105 gpm and will be available for re-use. Thus, the net water requirement will be about 420 gpm (about 680 acre-feet per year). This net water requirement will be pumped to the site along the private right-of-way and mineral claims described in Section 2.5.8.

A breakdown of water requirements, by project component, is presented in Table 3.2.2. Water required for dust control and reclamation is included in this table (Paraho 1981).

TABLE 3.2.1

SINGLE RETORT OPERATION

LAND REQUIREMENTS/STATUS

(Estimates)

Project Component	Acreage: Construction	Acreage: Operations	Ownership
Access Roads	127	51	BLM/Private
Mine Bench & Access Road	13	8	State of Utah
Shale Preparation & Handling	65	33	State of Utah
Retorting & Oil Recovery	12	8	State of Utah
Off-Gas Handling	14	10	State of Utah
Water Treatment and Ponds	17	12	State of Utah
Auxiliary Facilities	20	15	State of Utah
Retorted Shale Disposal	80	70	State of Utah
Shale Fines Storage	25	18	State of Utah
Surface Soils Storage	15	12	State of Utah
Other Storage	25	20	State of Utah
Construction Camp	100	0	Skyline
Water Right-of-Way	32.4	32.4	Private
Transmission Right-of-Way	21.6	21.6	BLM/State of Utah

Paraho 1981.

TABLE 3.2.2

SINGLE RETORT OPERATION

WATER REQUIREMENTS

(Estimated)

Project Component	gpm	acre-feet/yr
Underground (Mine) Non-potable (includes dust control)	41	66
Underground (Mine) Potable	5	8
Surface Facilities (Potable)	10	16
Surface Facilities (Non-potable) includes process, boiler feed, cooling, fire and dust control	9	15
Retorted Shale and Shale Fines Disposal (includes dust control)	265	428
Reclamation of Retorted Shale and Shale Fines Areas	93	150
	423	683

gpm = gallons per minute

Paraho 1981.

3.2.3 Manpower

The estimated construction and operation manpower requirements are presented in Table 3.2.3. Although abandonment and reclamation manpower requirements are included in this table, manpower needs for the construction camp maintenance and operation are not.

Construction. The construction phase will begin with site preparation activities in the fall of 1982 or early 1983. It will take approximately 42 months to complete construction. Manpower requirements are expected to rise steadily until early 1984, when an estimated 1,300-1,800 construction workers will be needed. Then, the number of required construction workers will decrease as operational personnel begin to arrive.

Operation. The operational period will last for approximately 30 months and is scheduled to begin in late 1985. Operational workforce requirements are expected to rise to approximately 700 and remain at that level throughout the single retort operational period. Abandonment and reclamation is expected to extend over a two and one-half year period and would require a workforce of approximately 200 workers.

3.2.4 Other Resource Requirements

Other resources required for the Single Retort Operation include: raw oil shale, electricity, motor fuel, lubricants, natural gas,

TABLE 3.2.3

SINGLE RETORT OPERATION

ESTIMATED MANPOWER REQUIREMENTS

	Mine			Plant			Overall		
Year	Construction	Operation	Total	Construction	Operation	Total	Construction	Operation	Total
1982	50	0	50	50	0	50	100	0	100
1983	188	0	188	663	0	663	851	0	851
1984	207	63	270	1225	38	1263	1432	101	1533
1985	200	225	425	138	250	388	338	475	813
1986	50	400	450	0	250	250	50	650	700
1987	0	225	225	0	225*	225	0	450	450

*This includes abandonment and reclamation workforce. A workforce of 200 workers will continue in abandonment and reclamation through 1989.

Paraho 1981.

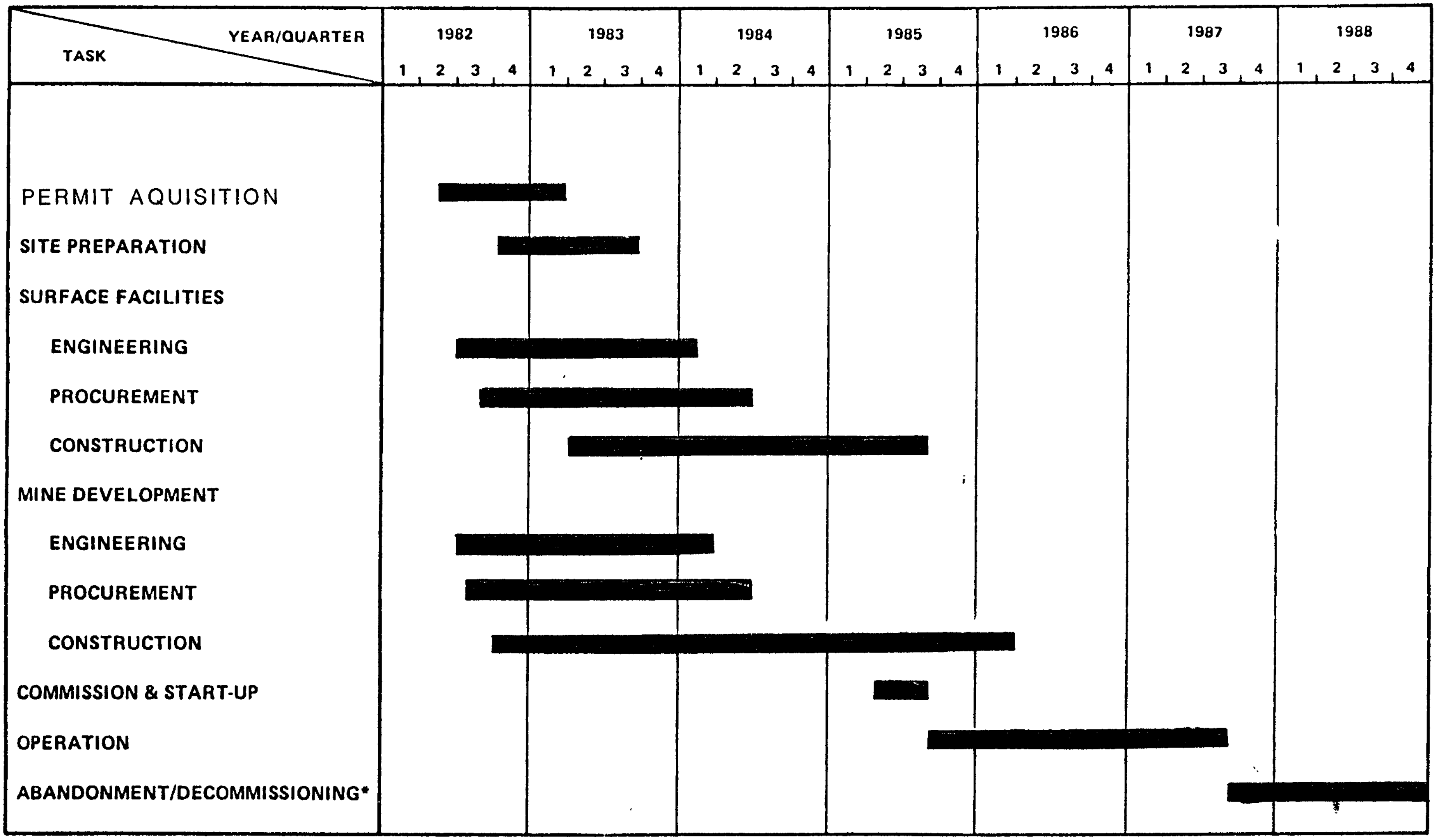
explosives, chemicals, and catalysts. This information is based on construction and operation activities to be performed on-site and on the off-site rights-of-way. The resources required for delivery of construction materials, employee transportation, and product distribution are not included herein.

Under normal operating conditions, the Single Retort Operation will require mine production of 19,700 tons per stream day of raw oil shale. The electrical requirements for the mine include the service and hoist buildings, the underground conveyor drive house, the ventilation fans, drills, crushers, pumps, and lighting. The total mine electrical power demand is about 8 MW. Diesel fuel required in the mine is estimated to be 6,300 gallons per day. A mixture of ammonium nitrate and fuel oil (AN/FO) will be the primary explosive. Approximately 10,740 pounds per day of AN/FO will be required (Paraho 1981).

It is estimated that 34 MW of electric power will be required to support the Single Retort facility. An additional 10 MW will be required for the construction camp. Diesel fuel required for processed shale disposal/storage and other plant activities is estimated to be 3,150 gallons per day. Approximately 1,000 gallons per day of gasoline will also be required for surface vehicles.

3.3 Project Schedule

The overall schedule for the Single Retort Operation is presented in Figure 3.3.1. This schedule includes site preparation,



* Alternatives include continued module operation,
Scale-up to commercial operation,
or Maintenance as a research facility.

PARAHO SINGLE RETORT OPERATION
PROJECT SCHEDULE
FIGURE 3.3.1

engineering, procurement, and construction for the mine and surface facilities, retort operation, and abandonment and reclamation activities. The commencement of site preparation, scheduled to start in late 1982, is contingent on the acquisition of required permits.

3.3.1 Construction

Initial site preparation is expected to commence in the fall of 1982 and would require approximately twelve months to complete. The initial site preparation includes right-of-way access road development, mine access road construction, and site utility needs development. Upon completion of initial site work, shaft sinking, conveyor incline and ventilation portal development will commence, requiring approximately 15 months. Preproduction mine development will start upon completion of shaft sinking and incline development, and will require about 25 months. Total preproduction time from start of shaft sinking to shale oil production is 33 months (Paraho 1981).

Construction of the surface facilities, including the shale handling, retorting, oil recovery, gas treating, and the retorted shale and raw shale fines disposal area, will begin in early 1983. It will take approximately 30 months to complete construction of the surface facilities.

3.3.2 Operation

Full mine production will commence upon completion of the mine development activities (expected to be in early 1986). At that time, up to 19,700 TPSD of raw shale will be produced. The mine will operate at that level for approximately 18 months.

The retort is scheduled to start up in late 1985. At that time, the off-gas handling, oil recovery, and by-product handling facilities will also commence operation. These facilities will continue operation for approximately 24 months.

3.3.3 Post-Operation

Abandonment and reclamation activities will begin in 1988. Abandonment will take approximately six months to one year to complete, while reclamation is expected to take two years to accomplish. Monitoring will be carried out for an additional three years to assure all reclamation standards are satisfied.

3.4 General Construction, Operation, and Reclamation Procedures

The procedures utilized for the construction, operation, and reclamation of the Single Retort facility will be similar to those discussed in the HIGH LEVEL SCENARIO (Section 2.4). The only differences are expected to be in terms of scale due to the smaller rate of production in comparison to the high level project. The procedures described in the HIGH LEVEL SCENARIO represent environmentally acceptable procedures which are in compliance with applicable federal, state, and local regulations. Therefore, alternative procedures are not considered.

3.5 Project Components

Major changes from the HIGH LEVEL SCENARIO are that the Single Retort Operation does not include oil upgrading (hydrotreating), oil distribution (pipeline), gas utilization (electric power generation). In general, the project components for the Single Retort Operation are identical to those described in Section 2.5.

References

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4.0 OTHER PROJECT ALTERNATIVES

In addition to the LOW LEVEL SCENARIO, the Single Retort Operation, Section 3.0, that was developed in response to the request by the BLM (Edwards 1981), Paraho has, during its engineering design, developed certain other alternatives to portions of the project. The other project alternatives discussed in this section include a phased schedule; raw shale fines utilization; resources (water, construction power); rights-of-way; construction camp location; product distribution; mining/materials handling; plant operations; the no-action alternative. With the exception of the no-action alternative, Paraho considers all these alternatives as viable options for inclusion in the Paraho-Ute Project.

4.1 Phased Schedule

The schedules for the HIGH LEVEL SCENARIO (Section 2.3) and the LOW LEVEL SCENARIO (Section 3.3) would be combined into a Phased Schedule. Main features of this schedule alternative are:

- Initial Construction (Phase I) 1983
- First Retort and Auxiliaries Operational 1986
- Final Phase Construction Begins (Phase II) 1987
- Full, Three Retort, Facility Operational 1990

This phased schedule is being considered as an alternative between the HIGH and LOW LEVEL SCENARIO schedules for several reasons. Among these are the following:

- Lower front-end capital costs.

- Lower Phase I operating costs.
- Opportunity of evaluating (and improving if required) the engineering, economic, and environmental aspects of Phase I before committing to the full scale, high level facility.

Additional details of this alternative are available in the Public Summary of the proposal to the U.S. Synthetic Fuels Corporation (Paraho and Davy-McKee 1982).

4.2 Raw Shale Fines Utilization

Since the amount of energy in the raw shale fines (assuming an equivalent of 26 gallons/ton oil content) represents about 60 trillion (60,000,000,000,000) Btu's of energy, Paraho is currently studying means of using that resource (Paraho 1982). Alternate uses of raw shale fines include combustion in a fluidized bed reactor to produce steam and electricity, briquetting-retorting for oil recovery, and off-site utilization. If the raw shale fines were utilized in any of these ways, the raw shale fines operation would be continuous; no storage pile, as described in Section 2.0, would be present.

Should a fluidized bed reactor be the selected use, it would be used in conjunction with the planned gas utilization in the co-generation of steam and electrical power. The additional electrical power produced from fines combustion would reduce the need for off-site electrical generation from fossil fuels.

Should briquetting-retorting be the selected use, the results would be either an increased production of all products, by-products, and wastes (described in Section 2.0) by approximately 10% or a reduction of the mining and shale handling operations by 10% in order to keep the remaining production levels as described in the HIGH LEVEL SCENARIO.

Finally, should the fines be transported off-site for utilization, they would be used as road-base materials, feedstock for a fines-type retorting operation, or one of the several experimental uses now under study.

4.3 Resources

4.3.1 Oil Shale

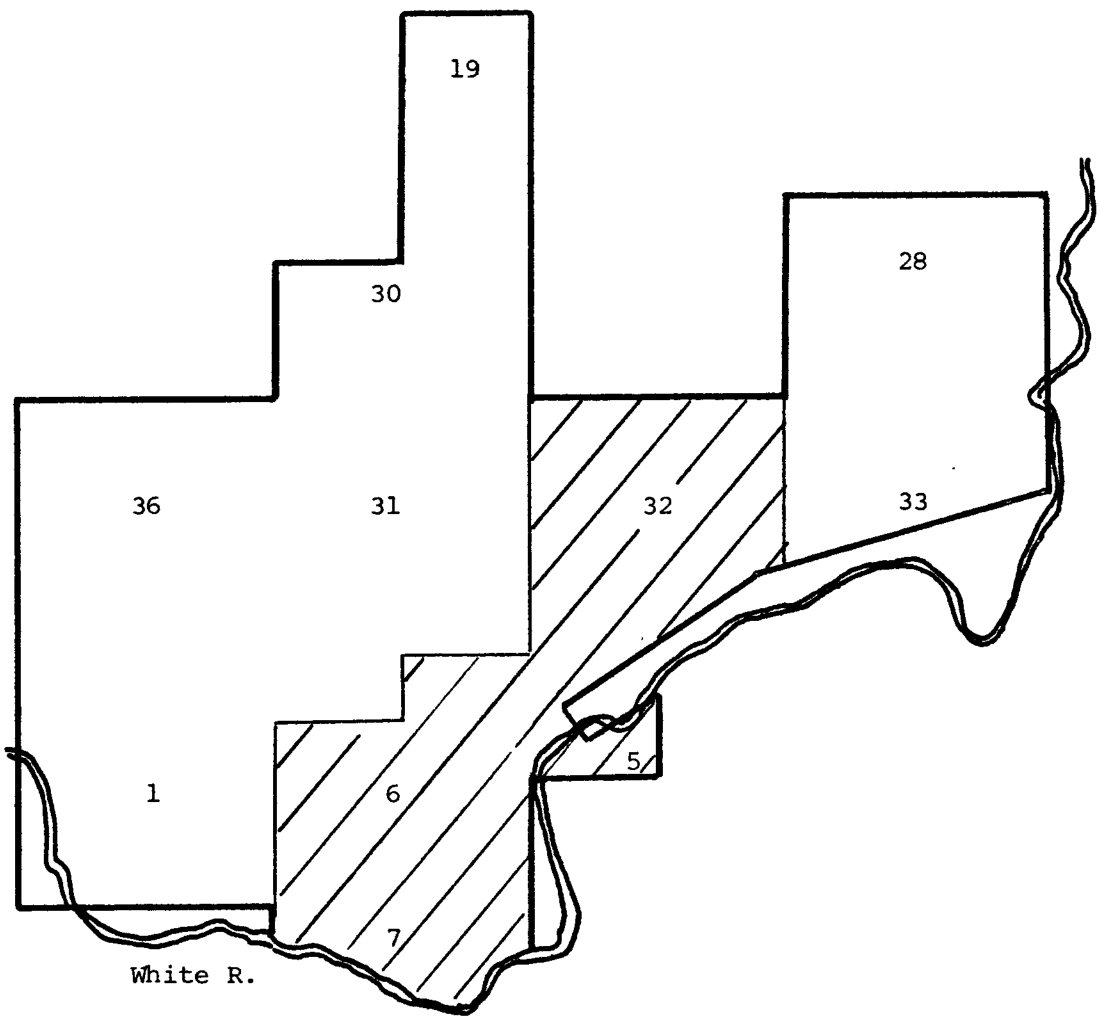
As mentioned in Section 2.1, Paraho is acquiring interest in supplemental tracts of land. These additional acquisitions, obtained through land exchange and acquisition, would consolidate Paraho's holding to approximately 4,610 acres (see Figure 4.1). These holdings would allow Paraho to proceed with a long-range alternative - operation at full capacity for more than 30 years. This alternative increases the 340 million tons of oil shale reserves in place for the high level project (see Section 2.2.1) to an estimated 1,140 million tons (see Table 4.1).

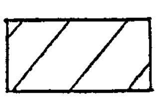
FIGURE 4.1

PARAHO-UTE

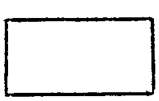
ADDITIONAL PROPERTY

ALTERNATIVE





Refers to the site described in Section 2.0.



Refers to additional property.

TABLE 4.1

Paraho-Ute Oil Shale Reserves

Additional Acquisition Alternative

Land Area	Acres	Estimated Resource in place, tons (MM)*
Sections 32,6,5&7	1,410	340
Section 33	320	80
Section 28	320	80
Section 31	640	160
Section 30	480	120
Section 19	160	40
Section 1	640	160
Section 36	640	160
Total	4,610	1,140

*Mining height of 77 feet.

MM = Million

Paraho and Davy-McKee 1982.

4.3.2 Water

There are several alternative sources of water for construction and operation.

Construction. Should the agreement to purchase water from American Gilsonite for construction use not be finalized, Paraho will purchase that water from the State of Utah. Water for temporary use would be obtained from the White River from Section 7 of the Paraho-Ute site. As a second alternative, Paraho would exercise the water rights on the White River that accompany the Skyline property.

Operation. Should the White River Dam not be constructed in time to supply water for the Paraho-Ute facility, two alternative actions are available. First, discussions with Deseret Generation and Transmission indicate that sufficient water would be available from the Green River delivered to the Bonanza Power Plant. This alternative would require a right-of-way (see Section 4.4). As a second alternative, Paraho would exercise the water rights on the White River that accompany the Skyline property.

4.3.3 Power During Construction

There are several alternatives for obtaining electrical power during construction. One is to utilize the existing power lines: the 12 kv line that crosses Section 6 and the 69 kv line that runs a few miles north of the Paraho-Ute site. The other is the generation of power on-site.

4.4 Rights-of-Way

There are no viable alternatives for the rights-of-way across public lands for the access roads, power lines, and product pipelines. Site access across private lands would eliminate the planned rights-of-way described in Section 2.5.8.; however, as indicated, locating all off-site facilities on private land is not a viable possibility.

The first alternate source of water for operations (see Section 4.3.2) would require a right-of-way permit across public lands from the Bonanza Power Plant to the town of Bonanza. From Bonanza, the water would be piped to the site using the privately-owned gilsonite claims (see Section 2.5.8).

4.5 Construction Camp Location

Alternate sites for the construction camp will be located near the project site on land Paraho has acquired. These sites would not require rights-of-way permits in connection with federal or state lands; however, access roads to these sites may require rights-of-way permits.

4.6 Product Distribution

There are several alternatives available for product distribution. The existing Wesco line, which crosses the Paraho-Ute site, could be used to transport a portion of the shale oil products to the Gary Energy Refinery in Fruita, Colorado. Another alternative would be to truck a portion to the Plateau Refinery located in Roosevelt, Utah. Finally, the spur pipeline, described in the HIGH LEVEL SCENARIO (see Section 2.5.8), could be used to transport hydrotreated oil to the midwest U.S. using a pipeline to be constructed from the shale region of western Colorado to Casper, Wyoming (Paraho 1982).

4.7 Mine/Materials Handling

The service shaft described in the HIGH LEVEL SCENARIO (see Section 2.5) is designed to transport workers and light equipment to the mine zone. An alternative would be to utilize the adit located at the mine bench as an entry for all equipment and workers and the preparation of shale for transportation to the surface. In that case, a service shaft would not be constructed and an inclined shaft may not be needed.

Backfilling of raw shale fines or retorted shale in the mine is considered as an alternative to above ground storage or disposal. Backfilling involves transporting the material to the mined-out areas of the mine. Although the backfilled material would assist in pillar support and reduce the possibility of surface subsidence, the environmental consequences of underground storage, or backfilling, are not well defined. Additional research will be needed before this alternative is considered.

4.8 Plant Operations

4.8.1 Second Generation Retort

Paraho plans to continue its research in retorting technologies. The technologies include operational and design modification to the direct heated mode and combination mode of retorting. If the results from this research show that these modifications show definite improvements, some of the retorts planned for the Paraho-Ute facility may be operating in the modified mode.

4.8.2 Naphtha Recovery

Removal of naphtha from the retort off-gas is being considered. The off-gas contains appreciable amounts of heavy, volatile organics (naphtha). The naphtha could be condensed from the gas and used to improve the crude shale oil quality and yields. If necessary, a portion of the removed naphtha could be fed back into the off-gas to serve as a fuel (Paraho 1982).

4.8.3 Sulfur Marketing

Manufacturer's process data have shown that the sulfur produced by the Stretford units may be marketable. If a market is available, the sulfur will be sold in a dry, crystalline form rather than disposed in the retorted shale pile (Paraho 1982).

4.9 The No-Action Alternative

Should the BLM choose the "no-action" alternative for the EIS covering the proposed rights-of-way on public lands, there would be an adverse impact on the Paraho-Ute Shale Oil Facility. The availability of adequate private lands suitable for alternate rights-of-way for water lines, roads, power lines, and product pipelines is uncertain. For the most part, the Paraho-Ute site is surrounded by public lands.

Should the plans to construct and build the Paraho-Ute Shale Oil Facility be abandoned because the BLM chooses the "no-action" alternative, the following would result:

- o The proposed Paraho-Ute Shale Oil Facility would not be built.
- o The Paraho technology would not be demonstrated on a commercial scale.
- o The production of 42,000 barrels of hydrotreated shale oil and other by-products, such as 30 megawatts of excess electrical power, would not occur.
- o The employment opportunities, the planned growth for the Uintah Basin, and additional tax revenues, both locally and to the State of Utah, would not be provided by Paraho.

- Our dependence on foreign oil would not be reduced.
- Our national defense posture and balance of trade would not be improved.

References

Edwards, J. D., (BLM). Letter to R. N. Heistand, Oct. 16, 1981.

Paraho Development Corporation. "Commercial Feasibility Study", DE-FC01-80RA5038, 1982.

Paraho Development Corporation and Davy McKee Corporation. "Public Summary. Paraho-Ute Shale Oil Facility Proposal for Financial Assistance. Presented to the United States Synthetic Fuel Corporation", June 1, 1982.

LIST OF FIGURES

LIST OF TABLES

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5.1 Baseline Air Quality/Meteorological Data

5.1.1 Monitoring Data

Ambient monitoring data has been collected on and near the Ua and Ub tracts by the White River Shale Project since late 1974 at up to 13 different sites. However, it is proposed to use data from only two of these sites in analyzing Paraho's oil shale operation. These sites are A6 and A7, shown in Figure 5.1.1.

Site A6 has operated continuously since 1974 and will be used to define baseline air quality and general atmospheric conditions in this area. Parameters measured at this site include SO_2, NO, NO_2, NO_x, TSP, CO, HC, O_3, and H_2S; WS and WD at three levels, T at two levels, ΔT, σ_θ, σ_w, dew point temperature, pressure, and net solar radiation. Air quality and stability data from this site have been shown in White River Shale Project (WRSP) annual reports to be representative of the entire area through comparisons with data at the other monitoring sites. This is also the only site where air quality monitoring was continued after 1976, so it is considered to be the best site to define baseline air quality up to operation of the proposed oil shale project.

Site A7 was operated only from late 1974 to 1976 when SO_2, TSP, H_2S, and wind data were collected. As can be seen from Figure 5.1.1, this site is located on the proposed Paraho lease tracts, and should be most representative of the actual wind flow for the site. Wind data from the north side of the river is

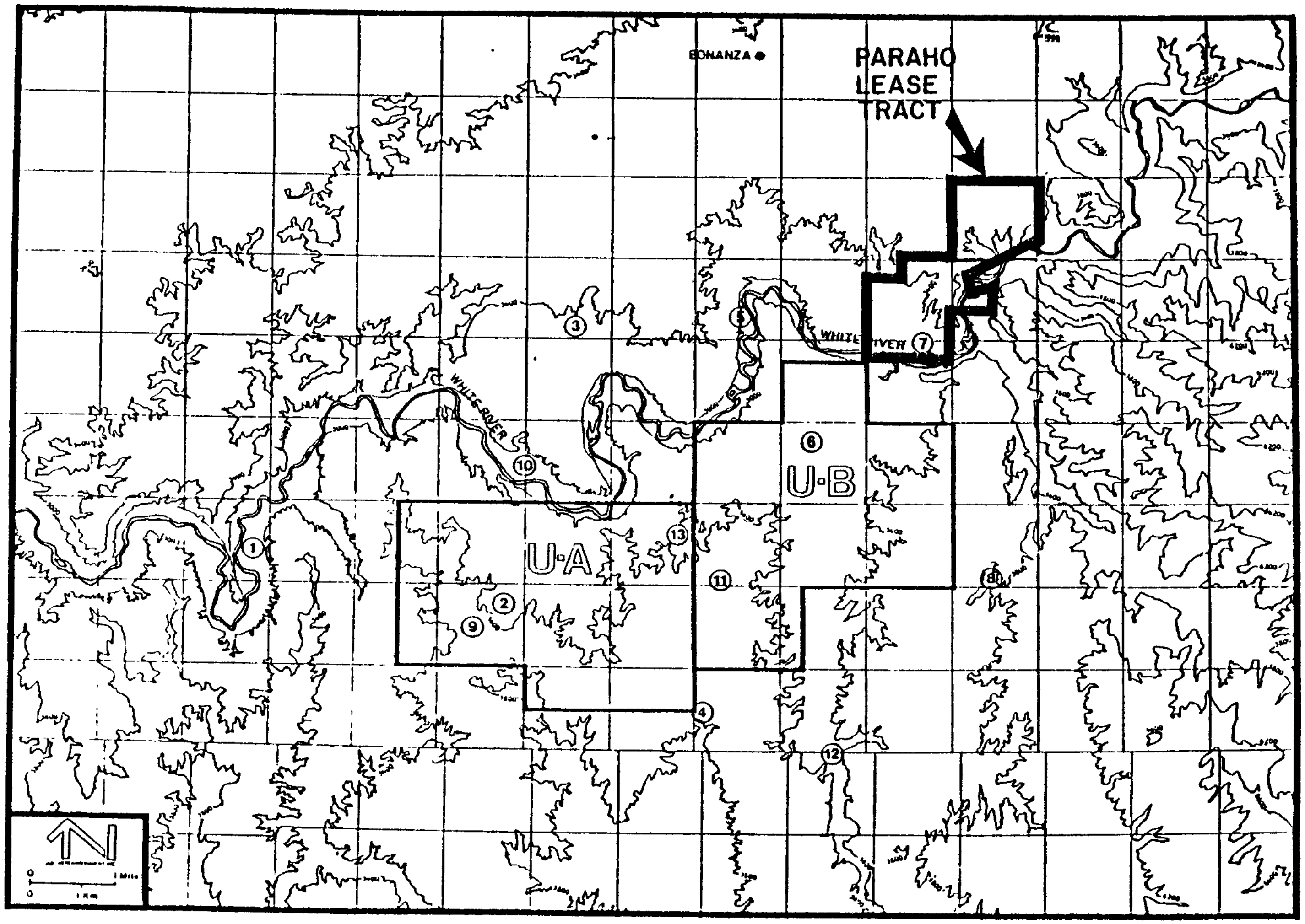


Figure 5.1.1

GENERAL LOCATION OF THE PARAHO LEASE TRACT considered essential to define the wind distribution for Paraho since drainage flows are a significant factor in this region. Therefore, a joint frequency distribution of wind data from this site (A7) and stability (based on σ_θ) data from Site A6 was compiled and is shown in Table 5.1.1.

From site set-up these sites have operated according to quality assurance guidelines, with new equipment or procedures added as new guidelines were established. A quality assurance plan addressing current PSD guidelines is on file with the EPA Region VIII for this monitoring. The on-site quality control program included regular zero and span checks and monthly calibrations. The QA program included quarterly internal performance audits as well as quarterly external audits performed by Rockwell International through the EPA program. Table 5.1.2 gives the results and dates of the external audits. Table 5.1.3 shows the dates of the regular instrument calibrations, while Table 5.1.4 gives the percent of data collected by month. A summary of air quality and meteorological data collected by WRSP is given in Table 5.1.5.

TABLE 5.1.1

Joint frequency distribution of wind and stability during 1976 for the Paraho oil shale operation.

STABILITY	SPD(MPS)) WIND DIR.	.670	2.540	4.740	6.930	9.610	12.520		TOTAL
A	N	.025	0.000	0.000	0.000	0.000	0.000	*	.025
A	NNE	0.000	0.000	0.000	0.000	0.000	0.000	*	0.000
A	NE	.012	0.000	0.000	0.000	0.000	0.000	*	.012
A	ENE	.012	0.000	0.000	0.000	0.000	0.000	*	.012
A	E	0.000	0.000	0.000	0.000	0.000	0.000	*	0.000
A	ESE	0.000	0.000	0.000	0.000	0.000	0.000	*	0.000
A	SE	0.000	0.000	0.000	0.000	0.000	0.000	*	0.000
A	SSE	0.000	0.000	0.000	0.000	0.000	0.000	*	0.000
A	S	.025	0.000	0.000	0.000	0.000	0.000	*	.025
A	SSW	.037	0.000	0.000	0.000	0.000	0.000	*	.037
A	SW	.037	.025	0.000	.012	0.000	0.000	*	.074
A	WSW	.012	.025	0.000	0.000	0.000	0.000	*	.037
A	W	.012	.062	0.000	0.000	0.000	0.000	*	.074
A	WNW	.012	0.000	0.000	0.000	0.000	0.000	*	.012
A	NW	0.000	0.000	0.000	0.000	0.000	0.000	*	0.000
A	NNW	.012	0.000	0.000	0.000	0.000	0.000	*	.012
A	TOTL	.197	.111	0.000	.012	0.000	0.000	*	.320

STABILITY	SPD(MPS)) WIND DIR.	.670	2.540	4.740	6.930	9.610	12.520		TOTAL
B	N	.025	.062	.012	0.000	0.000	0.000	*	.099
B	NNE	.062	.062	.025	0.000	0.000	0.000	*	.148
B	NE	.037	.037	.037	.049	0.000	0.000	*	.160
B	ENE	.012	0.000	0.000	.012	0.000	0.000	*	.025
B	E	.049	.049	.012	0.000	0.000	0.000	*	.111
B	ESE	0.000	.012	0.000	0.000	0.000	0.000	*	.012
B	SE	.025	.025	0.000	0.000	0.000	0.000	*	.049
B	SSE	.012	.012	0.000	0.000	0.000	0.000	*	.025
B	S	.074	.049	.012	0.000	0.000	0.000	*	.136
B	SSW	.185	.099	.012	.012	.025	0.000	*	.333
B	# SW	.173	.086	.037	.012	0.000	0.000	*	.308
B	WSW	.246	.173	.012	0.000	0.000	0.000	*	.431
B	W	.271	.296	.037	0.000	0.000	0.000	*	.604
B	WNW	.173	.074	.012	0.000	0.000	0.000	*	.259
B	NW	.049	.111	.025	0.000	0.000	0.000	*	.185
B	NNW	.074	.012	.012	0.000	0.000	0.000	*	.098
B	TOTL	1.466	1.158	.246	.086	.025	0.000	*	2.982

STABILITY	SPD(MPS)) WIND DIR.	.670	2.540	4.740	6.930	9.610	12.520		TOTAL
C	N	.345	.234	.111	0.000	0.000	0.000	*	.690
C	NNE	.259	.173	.074	.025	0.000	0.000	*	.530
C	NE	.283	.209	.222	.086	0.000	0.000	*	.801
C	ENE	.222	.099	.086	.012	0.000	0.000	*	.419
C	E	.086	.012	.037	.012	0.000	0.000	*	.148
C	ESE	.049	.025	.012	0.000	0.000	0.000	*	.086
C	SE	.111	0.000	.025	.012	0.000	0.000	*	.148
C	SSE	.086	.062	.025	0.000	0.000	0.000	*	.173
C	S	.357	.185	.123	.296	.160	0.000	*	1.121
C	SSW	.419	.320	.173	.370	.136	.025	*	1.442
C	SW	.924	.505	.222	.246	.025	0.000	*	1.922
C	WSW	.863	.542	.234	.123	.012	0.000	*	1.774
C	W	1.060	.579	.062	.025	0.000	0.000	*	1.725
C	WNW	.702	.407	.148	.012	0.000	0.000	*	1.269
C	NW	.579	.320	.148	0.000	0.000	0.000	*	1.048
C	NNW	.333	.086	.037	.025	0.000	0.000	*	.481
C	TOTL	6.679	3.758	1.737	1.244	.333	.025	*	13.777

TABLE 5.1.1 (Continued)

STABILITY	SPD(MPS)> WIND DIR.	.670	2.540	4.740	6.930	9.610	12.520		TOTAL
D	N	.949	.407	.283	.160	.025	0.000	*	1.824
D	NNE	1.355	.518	.419	.283	.025	0.000	*	2.600
D	NE	1.947	.616	.912	.518	.111	0.000	*	4.104
D	ENE	1.417	.333	.370	.271	.037	0.000	*	2.428
D	E	.628	.173	.136	.049	0.000	0.000	*	.986
D	ESE	.505	.111	.062	.074	0.000	0.000	*	.752
D	SE	.357	.160	.136	.074	.012	0.000	*	.739
D	SSE	.665	.173	.111	.357	.049	.025	*	1.380
D	S	1.171	.579	.628	1.725	1.146	.357	*	5.607
D	SSW	1.257	.863	.764	.616	.468	.197	*	4.165
D	SW	2.009	1.195	.579	.628	.099	.012	*	4.523
D	WSW	1.824	.727	.579	.616	.123	0.000	*	3.869
D	W	1.405	.801	.678	.542	.185	0.000	*	3.611
D	WNW	1.516	.592	.468	.419	.123	0.000	*	3.118
D	NW	1.245	.727	.505	.234	.025	0.000	*	2.735
D	NNW	.986	.530	.308	.148	.012	0.000	*	1.984
D	TOTL	19.236	8.503	6.938	6.716	2.440	.592	*	44.424

STABILITY	SPD(MPS)> WIND DIR.	.670	2.540	4.740	6.930	9.610	12.520		TOTAL
E	N	1.442	.296	.049	.062	0.000	0.000	*	1.848
E	NNE	1.442	.209	.099	.111	.074	0.000	*	1.935
E	NE	2.970	.394	.259	.296	.086	.037	*	4.042
E	ENE	3.130	.185	.086	.049	.037	0.000	*	3.487
E	E	1.935	.173	.049	.012	0.000	0.000	*	2.169
E	ESE	.715	.111	.062	.037	0.000	0.000	*	.924
E	SE	.850	.086	.074	.037	0.000	0.000	*	1.047
E	SSE	1.084	.197	.283	.259	.049	0.000	*	1.873
E	S	1.319	.431	.444	.407	.025	0.000	*	2.625
E	SSW	1.343	.419	.160	.037	0.000	0.000	*	1.959
E	SW	1.590	.493	.086	.049	0.000	0.000	*	2.218
E	WSW	1.269	.419	.086	.025	.012	0.000	*	1.811
E	W	1.368	.370	.209	.173	.209	.049	*	2.378
E	WNW	1.380	.296	.209	.197	.049	.037	*	2.169
E	NW	1.885	.271	.111	.049	.012	.012	*	2.341
E	NNW	1.996	.160	.074	.086	0.000	0.000	*	2.317
E	TOTL	25.718	4.510	2.341	1.886	.555	.136	*	35.145

STABILITY	SPD(MPS)> WIND DIR.	.670	2.540	4.740	6.930	9.610	12.520		TOTAL
F	N	.283	0.000	0.000	0.000	0.000	0.000	*	.283
F	NNE	.320	0.000	0.000	0.000	0.000	0.000	*	.320
F	NE	.444	0.000	0.000	0.000	0.000	0.000	*	.444
F	ENE	.616	0.000	0.000	0.000	0.000	0.000	*	.616
F	E	.197	0.000	0.000	0.000	0.000	0.000	*	.197
F	ESE	.062	0.000	0.000	0.000	0.000	0.000	*	.062
F	SE	.062	0.000	0.000	0.000	0.000	0.000	*	.062
F	SSE	.037	.012	.025	0.000	0.000	0.000	*	.074
F	S	.062	.012	.012	.012	0.000	0.000	*	.099
F	SSW	.086	0.000	0.000	0.000	0.000	0.000	*	.086
F	SW	.025	0.000	0.000	0.000	0.000	0.000	*	.025
F	WSW	.037	0.000	0.000	0.000	0.000	0.000	*	.037
F	W	.062	0.000	0.000	0.000	0.000	0.000	*	.062
F	WNW	.173	0.000	0.000	0.000	0.000	0.000	*	.173
F	NW	.407	0.000	0.000	0.000	0.000	0.000	*	.407
F	NNW	.407	0.000	0.000	0.000	0.000	0.000	*	.407
F	TOTL	3.278	.025	.037	.012	0.000	0.000	*	3.352

TABLE 5.1.2

Results and dates of Rockwell International's external audits of Site A6 on Tract Ub.

Date	NO	NO_x	O_3	CO	CH_4	THC	SO_2	TSP
11/76	1.087	0.952	0.965	1.044	0.977	1.019	0.818	IN
4/77	IN	IN	IN	1.107	0.923	0.935	0.717	IN
8/77	1.059	1.054	0.697	NA	NA	NA	0.913	+6.4
12/77	IN	IN	0.902	1.099	1.103	1.076	IN	-2.0
3/78	1.284	1.099	1.003	1.035	1.015	0.995	0.871	--
6/78	1.032	0.996	0.803	0.989	0.982	0.975	IN	-0.8
9/78	1.056	0.988	0.948	IN	IN	IN	1.381	+7.5
3/79	IN	IN	1.016	0.982	0.947	0.967	0.962	+8.0
6/22/79	1.073	1.096	1.001	0.973	0.977	0.969	--	IN
9/28/79	1.068	1.029	1.290	1.073	1.038	1.081	0.908	+3.4
11/12/79	IN	IN	0.954	1.088	0.996	0.985	IN	-11.7
3/25/80	1.003	1.017	0.954	0.919	0.944	0.943	0.712	-2.2

Results for gaseous pollutants are presented by comparing concentration C_1, delivered by the audit device, with concentration C_2 predicted from the latest station calibration. The relationship is described by the equation $C_2 = \beta C_1 + \alpha$, where α and β are the linear regression constants. Values for β (slope) are the ones given. TSP results are the percent difference between the station flow and the Rockwell flow.

IN = Temporarily inactive due to malfunction
NA = Not audited

TABLE 5.1.3

Instrument calibration dates for Sites A6 and A7.

Year	A6	A7
1974	11/17, 12/6	10/16, 11/21
1975	4/8, 6/15, 9/3, 11/21	5/15, 6/11, 8/15, 9/5, 11/21
1976	5/7, 6/30, 8/10, 9/26, 11/3, 12/14	2/29, 3/17, 5/6, 6/6, 8/13, 9/21, 11/4, 12/11
1977	1/11, 1/22, 3/4, 4/7, 4/14, 5/3, 6/12, 7/4, 8/15, 10/4, 11/23	
1978	1/23, 3/11, 4/21, 5/14, 6/24, 7/31, 8/4, 9/23, 11/15, 12/5	
1979	2/7, 3/12, 5/15, 5/18, 5/28, 6/21, 8/16, 9/17, 10/29, 11/28, 12/10	
1980	1/24, 3/3, 4/23, 5/21, 6/18, 7/23, 8/23, 9/22, 10/22, 11/19, 12/3	

TABLE 5.1.4

Percent of data recovery by month for Site A6.

Component / Month*		SO_2	NO_x	CO	O_3	THC	H_2S	TSP	T	RH	σ_θ
1977	1	100	97	100	99	100	100	100	100	100	100
	2	97	100	94	100	94	97	100	100	91	100
	3	93	59	100	100	100	93	100	100	100	100
	4	100	100	100	86	100	100	100	100	100	100
	5	100	100	100	91	100	100	100	100	97	100
	6	95	95	79	90	79	95	100	95	100	95
	7	97	99	95	99	95	97	100	99	100	97
	8	98	97	98	99	98	98	100	99	100	93
	9	98	100	98	98	98	98	80	100	100	100
	10	76	100	96	99	96	76	100	100	100	100
	11	70	100	100	95	100	70	100	100	100	100
	12	99	100	99	100	99	99	880	100	93	100
1978	1	97	100	97	100	97	97	100	100	100	100
	2	82	96	82	96	82	82	100	96	100	96
	3	98	100	98	100	98	98	60	100	95	100
	4	100	94	100	100	100	100	100	100	90	100
	5	100	100	100	100	100	100	100	100	100	100
	6	29	94	70	87	71	29	80	94	93	87
	7	22	69	69	100	69	22	20	100	100	89
	8	100	100	100	100	60	100	100	100	100	98
	9	100	100	25	83	0	100	100	100	100	100
	10	99	100	40	99	64	99	60	100	100	100
	11	100	100	0	76	26	100	80	100	86	98
	12	100	100	38	100	39	100	60	100	100	99
1979	1	93	74	66	93	66	93	100	93	92	91
	2	100	81	94	100	94	100	80	100	94	100
	3	100	94	100	100	100	100	100	100	0	100
	4	100	99	100	95	100	100	80	100	99	100
	5	100	100	92	100	92	100	80	100	97	100
	6	100	100	100	100	100	100	80	100	99	100
	7	100	100	100	100	100	100	80	96	100	100
	8	100	100	100	100	100	100	100	100	93	100
	9	100	100	90	94	90	100	100	99	91	100
	10	100	94	89	72	89	100	100	100	90	100
	11	100	60	100	100	100	100	80	100	100	100
	12	100	0	100	100	100	100	80	100	100	100
1980	1	96	69	91	99	—	--	87	100	0	100
	2	97	18	100	96	—	--	90	75	0	100
	3	100	78	99	98	—	--	90	100	0	100
	4	100	100	69	63	—	--	90	100	0	100
	5	100	100	87	100	—	--	100	100	95	100
	6	100	100	100	100	—	--	90	100	100	100
	7	100	100	100	100	—	--	100	97	100	100
	8	100	100	100	100	—	--	100	97	100	100
	9	100	100	100	100	—	--	100	100	100	100
	10	100	100	100	100	—	--	90	100	100	100
	11	100	100	100	100	—	--	90	100	100	100
	12	100	100	100	100	—	--	90	100	100	99

*These data were not readily available for 1974-1976.

Table 5.1.5

SUMMARY OF AIR QUALITY AND METEOROLOGICAL DATA COLLECTED ON TRACTS Ua AND Ub

Site	Components	Period
A1	WS, WD	12/74-4/76
	SO_2, TSP, H_2S	4/75-4/76
A2*	WS, WD, T, ΔT, σ_θ, σ_w, RH	1/75-1/77
	SO_2, TSP, H_2S, HC, CO, NO_x, O_3	12/74-4/76
	COH, b_{scat}	12/74-1/77
	Trace metals	1/75-12/76
A3	WS, WD	12/74-1/77
	SO_2, TSP, H_2S	12/74-1/77
	HC, CO, NO_x, O_3	12/74-4/76
A4	WS, WD, T, σ_θ	12/74-present
	SO_2, TSP, H_2S	2/75-1/77
A5	WS, WD	11/74-4/76
	SO_2, TSP, H_2S	11/74-4/76
A6*	WS, WD, T, ΔT, σ_θ, σ_w, RH, BP, SR	1/75-present
	SO_2, TSP, CO, NO, O_3	12/74-present
	HC, H_2S	12/74-12/79
	Rawinsonde	1/75-1/76
A7	WS, WD	11/74-1/77
	SO_2, TSP, H_2S	11/74-1/77
A8	WS, WD	11/74-4/76
	SO_2, TSP, H_2S	1/75-4/76
A9	WS, WD, T	12/74-4/76
A10	WS, WD, T	11/74-1/77
A11	WS, WD, T	11/74-present
A12	WS, WD, T	11/74-4/76
A13	WS, WD, T	5/76-present

*30-meter towers with meteorological measurements at 10, 20 and 30m.

5.1.2 Air Resources

This section describes the climate, meteorology, and air quality of the Paraho project tract area. These conditions on the Paraho tract will be characterized using the data from Federal Oil Shale Lease Tracts Ua and Ub, adjacent to the Paraho tract to the southwest. Because of the proximity and topographic similarity of the Paraho Ua - Ub tracts, air quality should not deviate significantly throughout the area, currently designated attainment for all pollutants. Figure 5.1.1 showed the general location and topography of the study area, as well as the locations where meteorological and air quality data were collected.

Summary of Climatology

Regional Climate. This section describes the climate of the general area of the Paraho project. The leased tract, located in the east-northeast section of Utah, has complex topography where climate varies with altitude. The Paraho tract is in the Uinta Drainage Basin along the White River. The basic climate type (Trewartha, 1961) is semiarid and undifferentiated highlands. Temperatures are cold in winter and, except for higher elevations, warm in summer. Precipitation falls from air masses of Pacific origin and occurs most frequently in the winter half of the year. Variations in weather are related to synoptic-scale high and low pressure systems that move with the mid-latitude westerlies.

The horizontal transport of an air mass is a consequence of large-scale differences in air pressure. The determining factor in Utah's weather during the winter months is the location and strength of the intermountain region high pressure cell. Figure 5.2.1 shows the normal January sea-level pressure and temperature. Storm tracks during mid-winter tend to pass north through Montana and south through Colorado. After February, storm tracks become more prevalent over Utah as the strength of the basin high wanes. This weakening of the high pressure system causes higher precipitation during the spring months in northeastern Utah.

During the summer months (Figure 5.1.2), the pressure is lower over Utah with periods of moisture from the south bringing

a. January

b. July

FIGURE 5.1.2 Normal January and July sea level pressure (solid lines) in mb and temperature in °F (dashed lines).

Source: U.S. Weather Bureau, 1952.

scattered thundershowers. Normally, moisture from the south is carried by winds aloft several times during the period June into September. Strong insolation from the sun causes differential heating of the surface and thunderstorms form in the moist air.

Site-Specific Climate. Averages and trends of meteorological readings from the Ua and Ub tracts which contribute to the climatological picture are discussed here. The monitoring sites used to characterize the climate in the Paraho area were shown in Figure 5.1.1. The topography of the Paraho tract ranges from just below 5,000 feet at the bed of the White River to over 5,700 feet just 3/4 of a mile to the northwest. The Ua and Ub tracts are south of the White River and are similar in topography to the Paraho tract, running from below 5,000 feet at the river bed to over 5,800 feet about two miles south.

Temperatures can vary more than 10°F (6°C) over short distances where the terrain is complex. Temperature was measured at a number of locations near the Paraho project area. Some spatial variations, generally attributable to topography, were evident from this data. Usually, temperature decreases with increase in elevation. However, on clear, calm nights, cold air drains from the surrounding terrain into protected valleys during nighttime radiational cooling. Consequently, extreme temperatures are often recorded in the valleys. The maximum, mean and minimum temperatures at three different elevations recorded during 1975 and 1976 are given in Table 5.1.6

Table 5.1.6

THE MAXIMUMS, MEANS, AND MINIMUM TEMPERATURES MEASURED AT DIFFERENT ALTITUDES DURING 1975 and 1976 in $^{\circ}C$.

Altitude (feet)	Maximum		Mean		Minimum	
	1975	1976	1975	1976	1975	1976
5,880	33	36	9.3	9.8	-16	-20
5,240	34	36	7.3	8.1	-20	-26
4,850	35	42	2.5	9.8	-31	-27

One site (A6) was located at an altitude of 5,240 feet and had a 100-foot (30-m) tower that recorded temperatures at three levels. Figure 5.1.3 shows the average diurnal variation in temperature for January and July for the 33-foot (10-m) level at this site during the 1975-1980 period. The diurnal variation shown in this figure should be similar to what would be observed at the Paraho site. The daily maximum temperature was generally observed between 1400 and 1500 MST while the daily minimum was usually between 0400 and 0500.

Monthly average temperatures during six years from 1975 through 1980 at this site (A6) are shown in Figure 5.1.4. Average monthly minimums and maximums for this period are also shown. These values did not vary much from year to year. Temperatures at this site varied from a low of -22°F (-30°C) during January 1979 to a high of 97°F (36°C) in July of 1976 and 1978 and August of 1979. The average temperature for all years was 45°F (8°C).

A network of precipitation gauges was established on or near Tracts UA and Ub to monitor annual precipitation. The network was first established in the last quarter of 1974, and ranged from two to 13 gauges operating throughout the year.

From data collected thus far, two major factors account for variations in precipitation from station to station. The primary factor is variation in terrain. In general, precipitation was heavier on ridgetops and lighter in valleys. This orographic

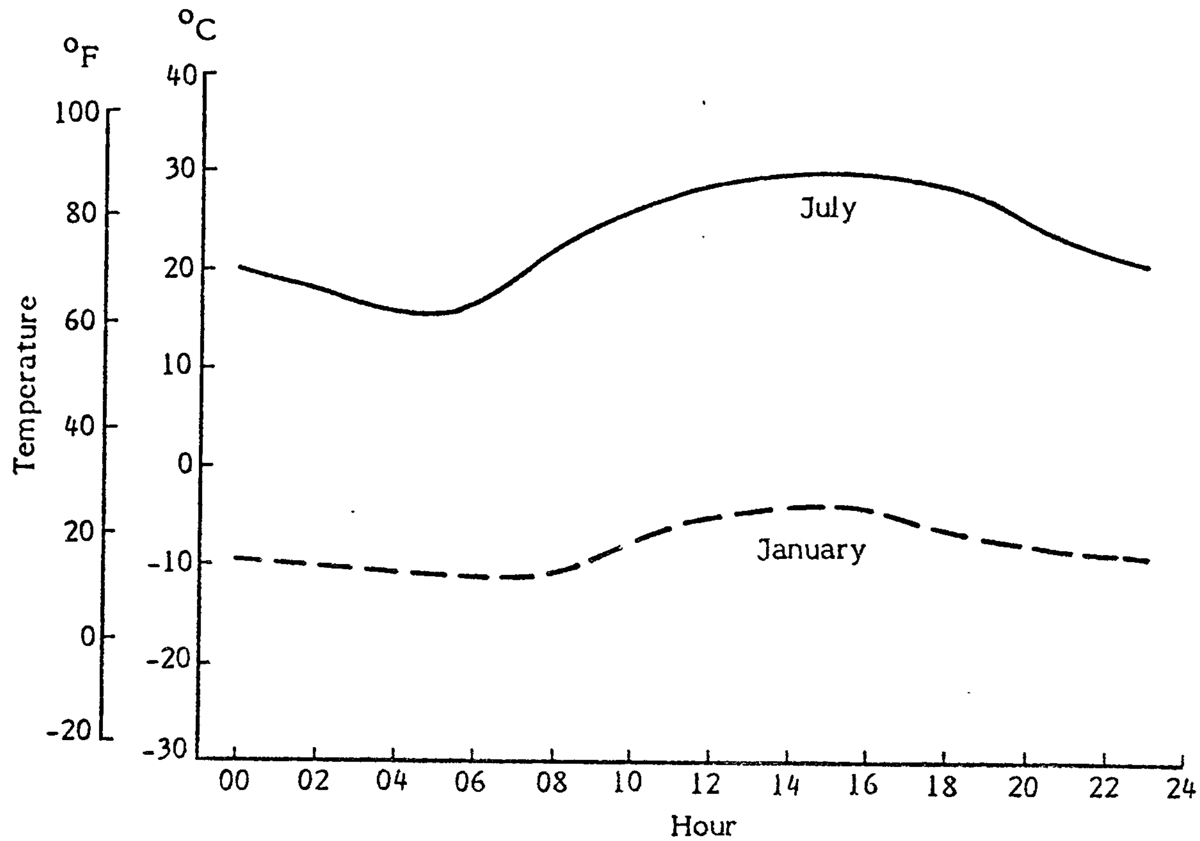


Figure 5.1.3

DIURNAL VARIATION OF MEAN TEMPERATURES AT SITE A6 DURING 1975 - 1980

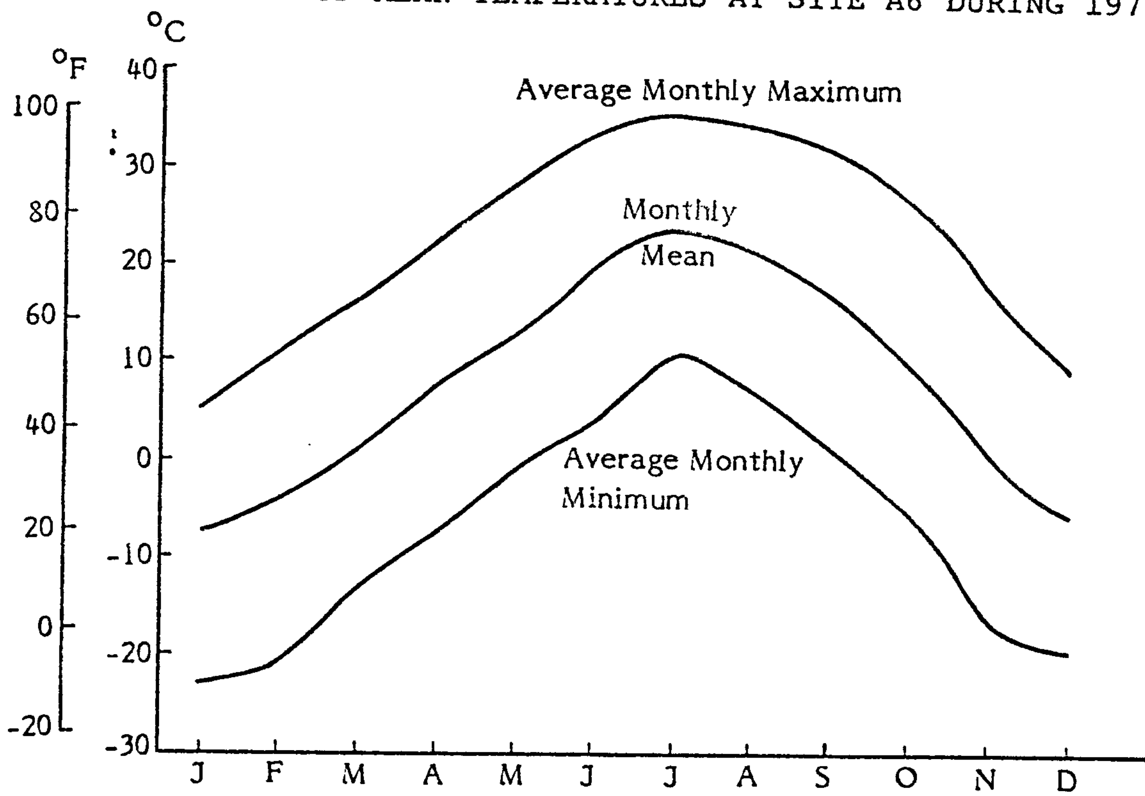


Figure 5.1.4

AVERAGE MONTHLY MAXIMUM AND MINIMUM AND MONTHLY MEAN TEMPERATURE AT SITE A6 DURING 1975 - 1980 effect will produce approximately a three-inch increase in precipitation per 1,000-foot increase in elevation. The annual precipitation average ranged from 10.90 inches (27.69 cm) for the highest station to 8.36 inches (21.13 cm) for the lowest station. The second factor is the slow-moving, intense, isolated thunderstorms that cross the tracts. The effects of these storms may override the orographic effects at some stations.

The heaviest rainfalls can be expected to occur in August during the thunderstorm season (U.S. BLM, 1977). A maximum 24-hour rainfall of up to 2.4 inches can be expected once every 100 years in this area. The mean number of days with measurable precipitation is about 80 (U.S. Environmental Data Service, 1968).

Annually, thunderstorms occur on approximately 35 days in east-northeast Utah (Landsberg, 1969). They occur predominantly in the late spring, summer, and early fall, most frequently in the afternoon.

Annual snowfall is highly dependent on terrain elevation and on the orientation of mountains and mountain ranges. Elevations in the Paraho area range from a little less than 5,000 feet at the White River bed to 5,730 feet. Annual snowfall in this area ranges between 20 and 30 inches, and generally falls between October and May (McKee, 1972).

Most of the water that runs into the White River system comes from snowmelt at higher elevations. No general flooding occurs during normal snowfall and normal springtime temperatures. However, during heavy snow-cover years or sudden spring warming (or both), flooding can occur. Local flash floods can also occur during heavy rains from intense thunderstorms during the summer months.

Relative humidity has been measured since late 1974 at Site A6 on Tract Ub. In general, the air on the tracts is drier in summer than in the winter. The highest readings are found in the winter from 0400 through 0800 MST and average about 80%. The lowest readings occur from 1400 to 1700 MST in the summer, with values around 25%.

The diurnal variation of relative humidity is approximately the reciprocal of temperature, indicating that the amount of moisture in the air remains fairly constant during a typical day in this region. Figure 5.1.5 shows the average diurnal variation in relative humidity in January and July during 1975-1980.

Elevation differences can be responsible for considerable variation in the relative humidity from one location to another. Relative humidity tends to decrease with an increase of altitude. The average annual humidity at Site A6 is 52 percent.

Evaporation from ground pans has been measured since 1975. Evaporation data collected for the freeze-free period,

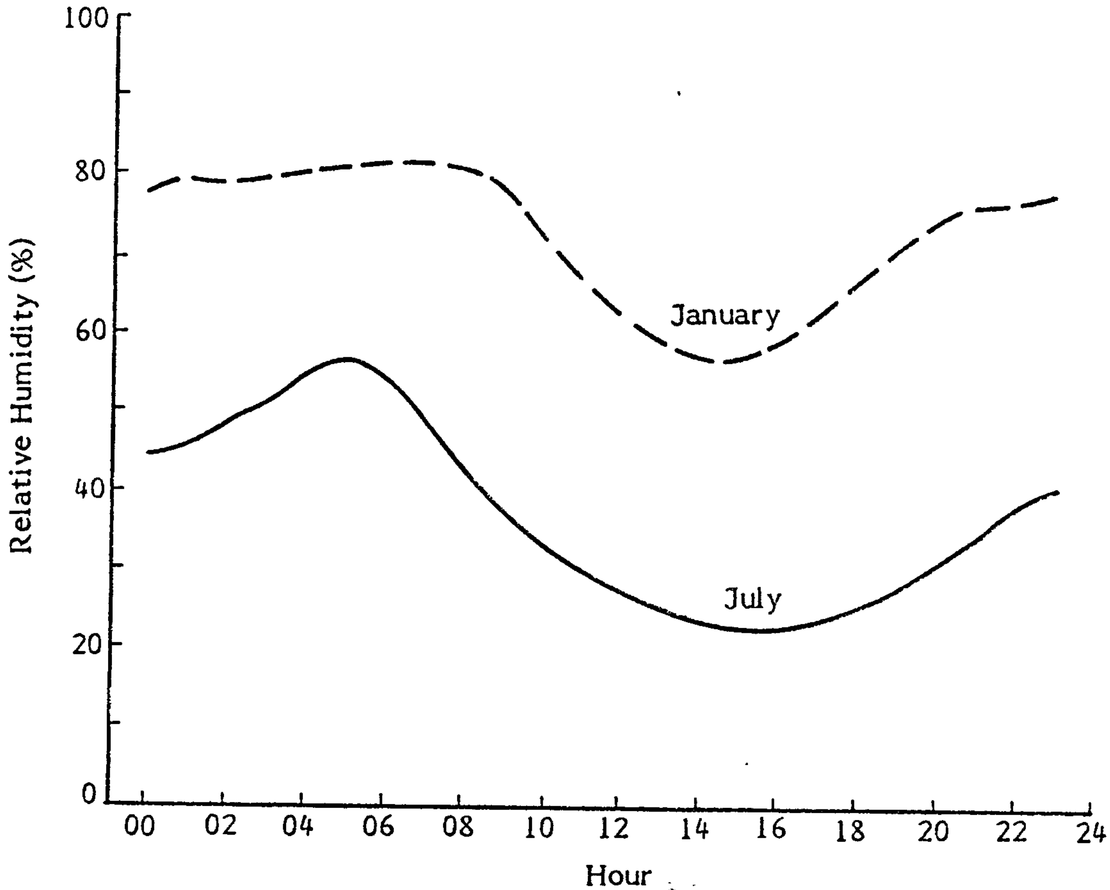


Figure 5.1.5

DIURNAL VARIATION OF MEAN RELATIVE HUMIDITY AT SITE A6 DURING JANUARY AND JULY 1975 - 1980 approximately May through September, indicated an average total pan evaporation of approximately 38 inches (97 cm).

Heat flux was determined by measuring the net thermal radiation at Site A6. This parameter is the amount of heat received from the sun minus the amount lost by the earth during radiative cooling. Heat flux affects the stability of the atmosphere and the solar radiation influences the rate of various photochemical processes.

Figure 5.1.6 shows the average hourly net solar radiation on the tracts during January and July for 1975-1980. As should be expected, the solar radiation is higher in the summer than winter due to longer days, more intense sunlight, and less cloudiness. Highest values during the day generally occurred between 1100 and 1200.

Barometric pressure is an indicator of the position and intensity of major weather systems passing over the tracts. Both the highest and lowest values of pressure generally occur during the October-April period in conjunction with the passage of winter storms and the presence of the Basin High. During the summer, the air mass systems are much weaker and, consequently, the pressure shows less fluctuation.

The pressure during 1975 through 1980 averaged 24.84 inches (631 mm) of Hg at Site A6 (5,246 feet). The highest pressure

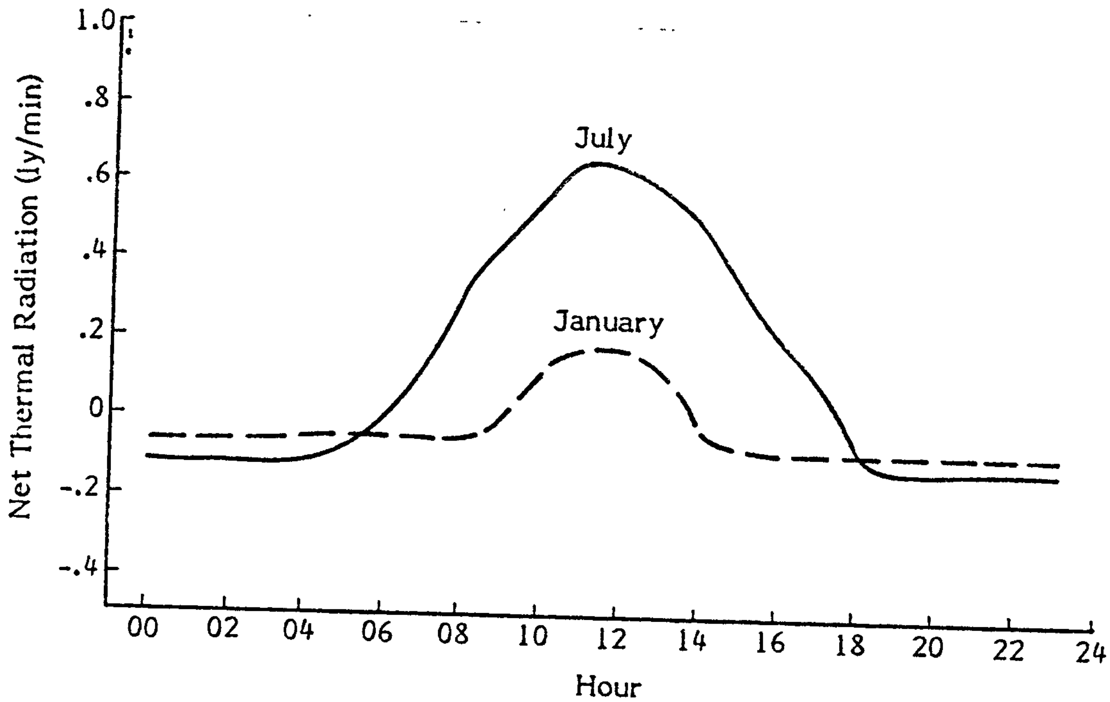


Figure 5.1.6

DIURNAL VARIATION OF THE MEAN NET THERMAL RADIATION DURING 1975 - 1980 AT SITE A6 value observed on the tracts during these five years was 25.43 inches (646 mm) of Hg in November 1975 and 1979, and the lowest value was 24.17 inches (614 mm) during March and April 1975 and January 1980.

Meteorology

Unlike climatology, which deals with general atmospheric conditions and averages over the long-term, meteorology is concerned with the specifics of motion in the atmosphere, and the diffusion of the materials in it. Therefore, this section will address the topics of surface flow, upper air meteorology, and diffusivity.

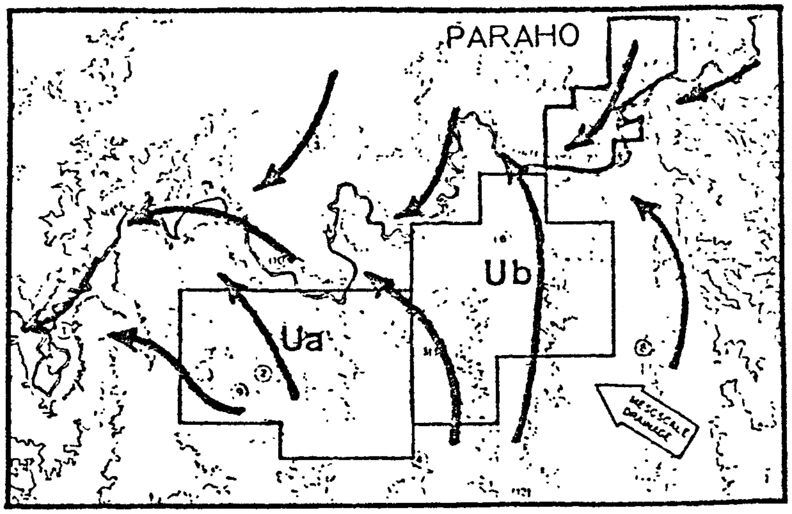
Surface Flow. Surface winds have been measured near the Paraho tract at a number of sites since late 1974. The rugged terrain features in the area complicate the airflow pattern. Table 5.1.7 lists the prevailing direction and average speed by month for four of these wind sites. This table shows some spatial variation in wind speed on the tracts. Site A10 is a riverbed site, Site A4 is the highest site on the tracts, Site A6 represents mid-altitude level in the area, and Site A7 was north of the river bed and located on the Paraho tract. The prevailing directions at Sites A6, A10, and A7 represent drainage flows. The prevailing flow at Site A4 is synoptic.

Generally, nighttime drainage flow prevails throughout the year. Figure 5.1.7 shows the typical airflow streamlines for

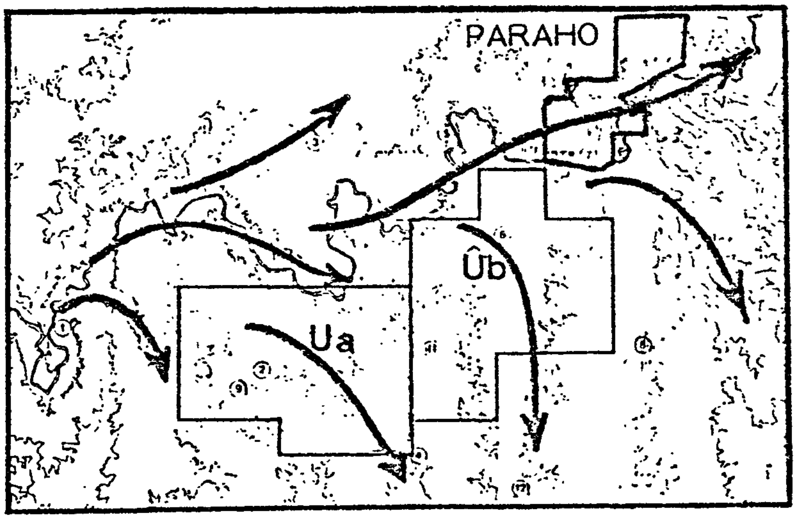
Table 5.1.7

AVERAGE MONTHLY WIND SPEEDS (MPH) AND PREVAILING DIRECTION ON THE Ua-Ub TRACTS

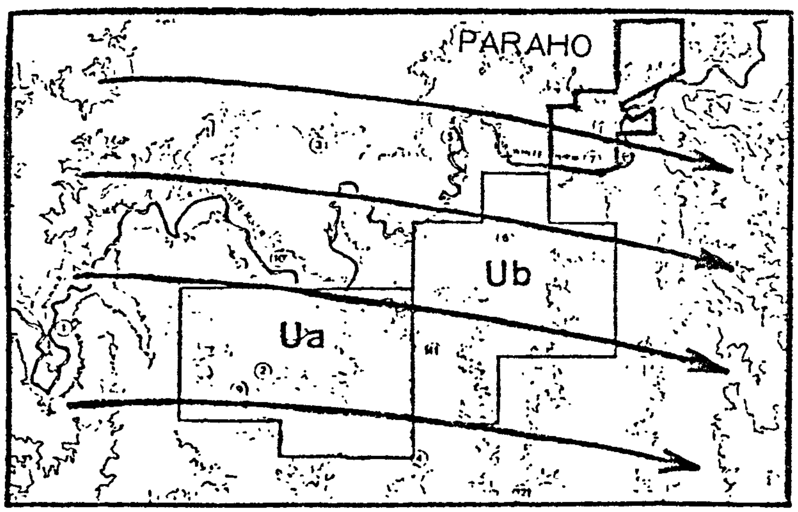
Month	Site							
	A4 (1975-1980)		A6 (1975-1980)		A10 (1974-1977)		A7 (1975-1977)	
	Direction	Speed	Direction	Speed	Direction	Speed	Direction	Speed
January	W	4.7	W	4.4	N	2.8	NE	3.5
February	W	5.1	W	5.3	NE	3.5	WNW	4.8
March	W	6.8	SE	7.2	NNE	4.8	W	6.8
April	W	7.8	SSE	8.6	NNE	5.5	SSW	8.0
May	SW	7.8	SSE	9.2	NNE	5.0	SSW	7.3
June	SW	8.5	SSE	9.8	NNE	5.5	VAR	8.5
July	WNW	7.2	SSE	7.8	NNE	4.5	VAR	6.8
August	WNW	7.5	SSE	8.2	NNE	5.0	SSW	7.5
September	WNW	6.7	SSE	7.3	NNE	4.0	NE	6.0
October	WNW	5.8	SE	6.6	NNE	3.8	NE	5.5
November	W	5.2	SE	5.8	N	3.3	NE	4.2
December	W	5.3	SE	4.9	N	2.8	NE	3.5
Annual	W	6.5	SSE	7.2	NNE	4.2	NE	6.0



a. EARLY MORNING DRAINAGE FLOW



b. TRANSITIONAL FLOW



c. AFTERNOON SYNOPTIC FLOW

Figure 5. 1.7TYPICAL AIR FLOW PATTERNS
IN THE STUDY AREA

the early morning drainage pattern. The solid lines are estimated flow streamlines. The large open arrow depicts the mesoscale flow direction in the greater White River drainage basin. The drainage pattern does not deviate significantly and is always from higher to lower terrain.

Figure 5.1.7 shows an upslope pattern that is transitional between drainage and synoptic flow. The surface-based inversion that results from strong radiative cooling begins to lose some of its strength shortly after sunrise. As the morning progresses, the heat gained by the surface from solar radiation exceeds that lost by terrestrial radiation to the sky and the soil temperature rises, warming the air above. This creates a pressure difference resulting in upslope flow. This pattern is transitional and generally lasts less than an hour, but is important to the understanding of dispersion of pollutants since plume fumigation (mixing of an elevated plume to the ground) would occur under this condition. Because of its brevity, this pattern is lost in hourly-average wind direction tabulation. This pattern begins earlier during the summer months than during the winter when the sun rises later.

Figure 5.1.7 shows afternoon streamlines on the tracts. Very little direction difference is noted from site to site but the average speeds are higher during the summer. This is the average synoptically-induced westerly flow that is encountered in this portion of Utah throughout the year.

Figure 5.1.8 displays the five-year average hourly wind speeds for January and July at Site A7 (on the Paraho tract). The January speeds are practically the same throughout the day. The wind speeds reach an average peak of about 11 mph (5 m/s) between 1400 and 1600 during July.

Wind speed changes throughout the year are indicated on Figure 5.1.9 which shows the monthly-averaged wind speeds and standard deviations, along with the peak wind speed for each month, at Site A7. The average wind speeds increase through spring and decrease thereafter. The peak wind during 1975 through 1976 of 39.5 mph (17.7 m/s) occurred during April 1976.

Figure 5.1.10 shows the directional wind roses at eight monitoring stations on the tracts for the middle month of the four seasons (January, April, July, and October). Although individual months may show different prevailing directions, east-southeast has been the most prevailing direction at Sites A6, A11, and A13 throughout the period. The frequent occurrence of the east-southeast wind is a direct result of the drainage flow at these sites. The prevailing direction at Site A2 is south, which is drainage flow at that site. The prevailing direction at Sites A7, A3, and A10 is from the north-northeast which is drainage flow at these sites. Site A4 has prevailing direction from the westerly quadrant. This site is situated near the top of a hill and the synoptic flow prevails. Since drainage winds prevail

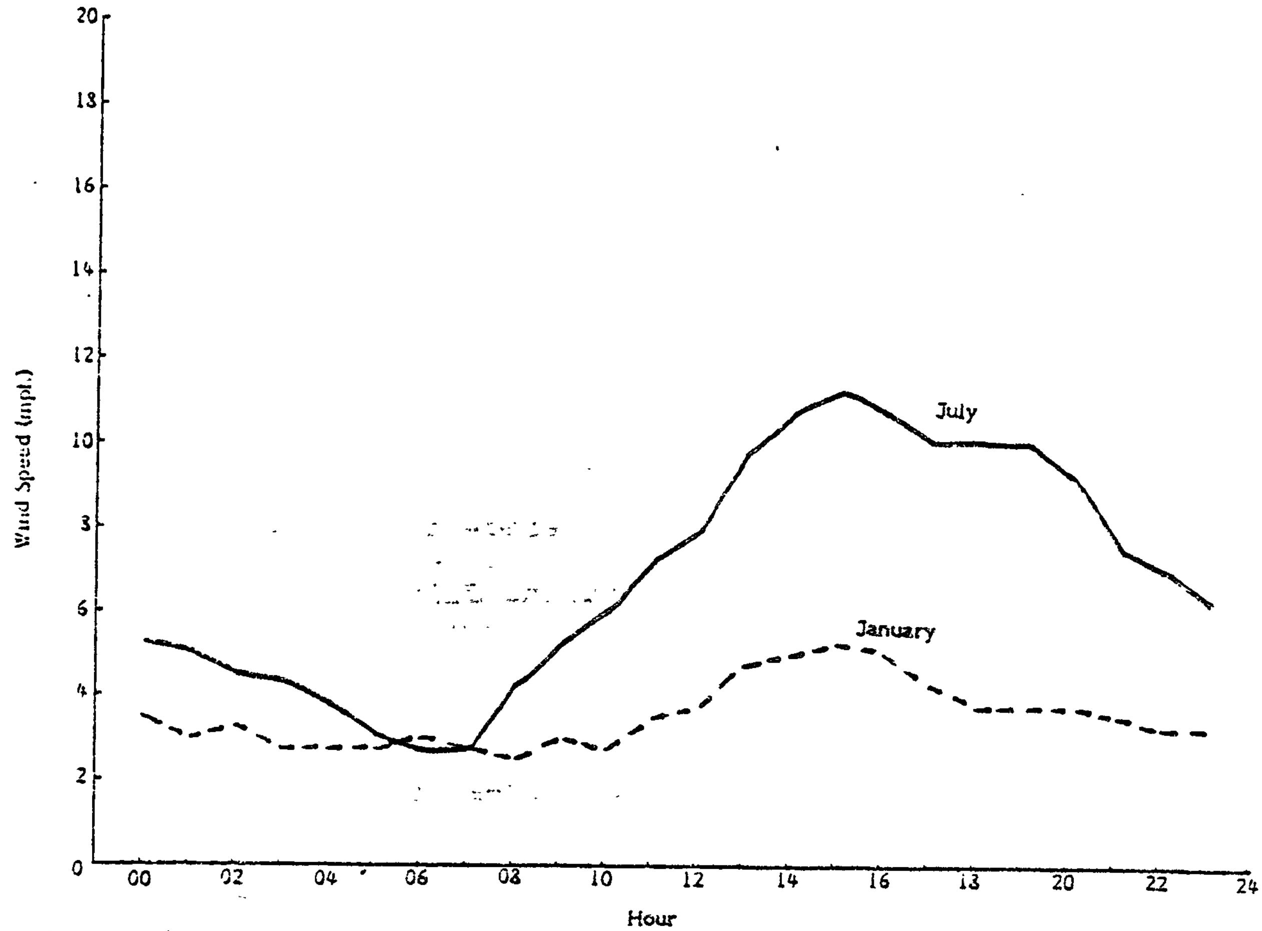


FIGURE 5.1.8 Diurnal variation of mean wind speed during January and July 1975-1976 at Site A7.

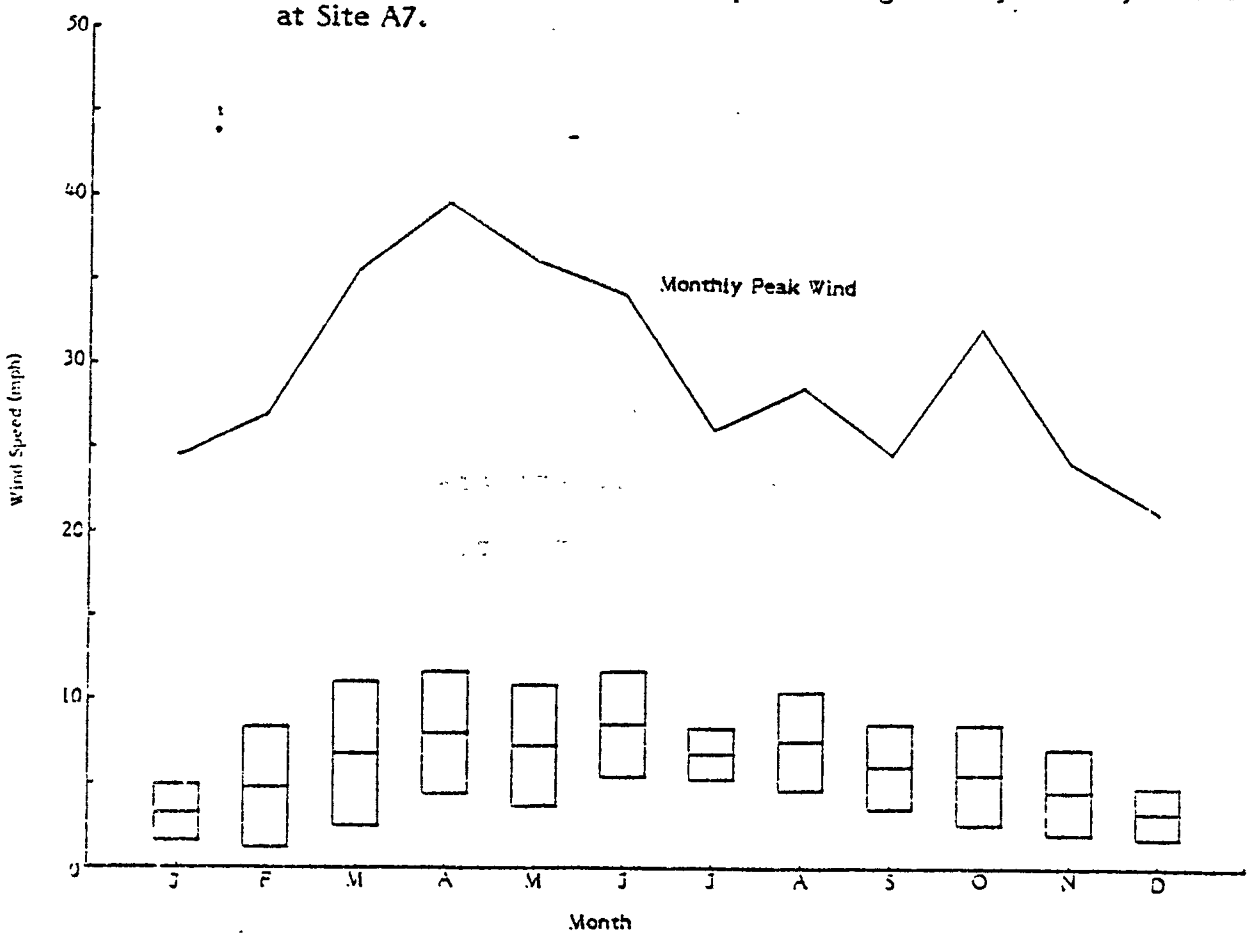
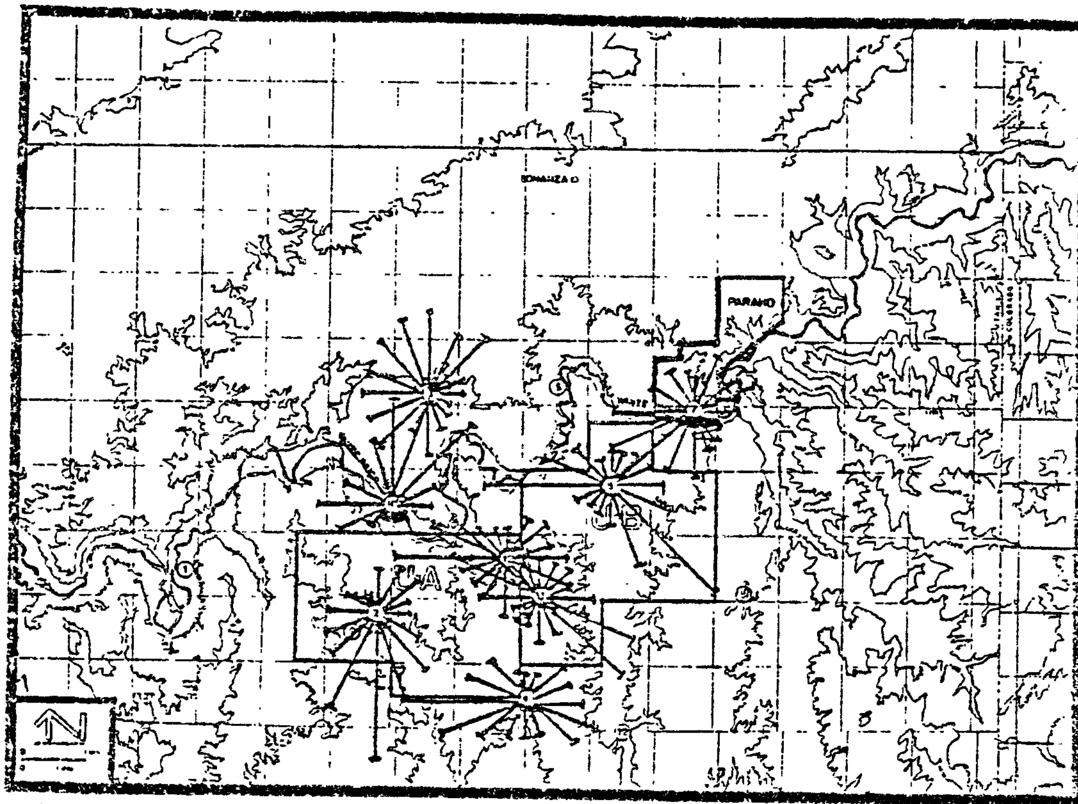
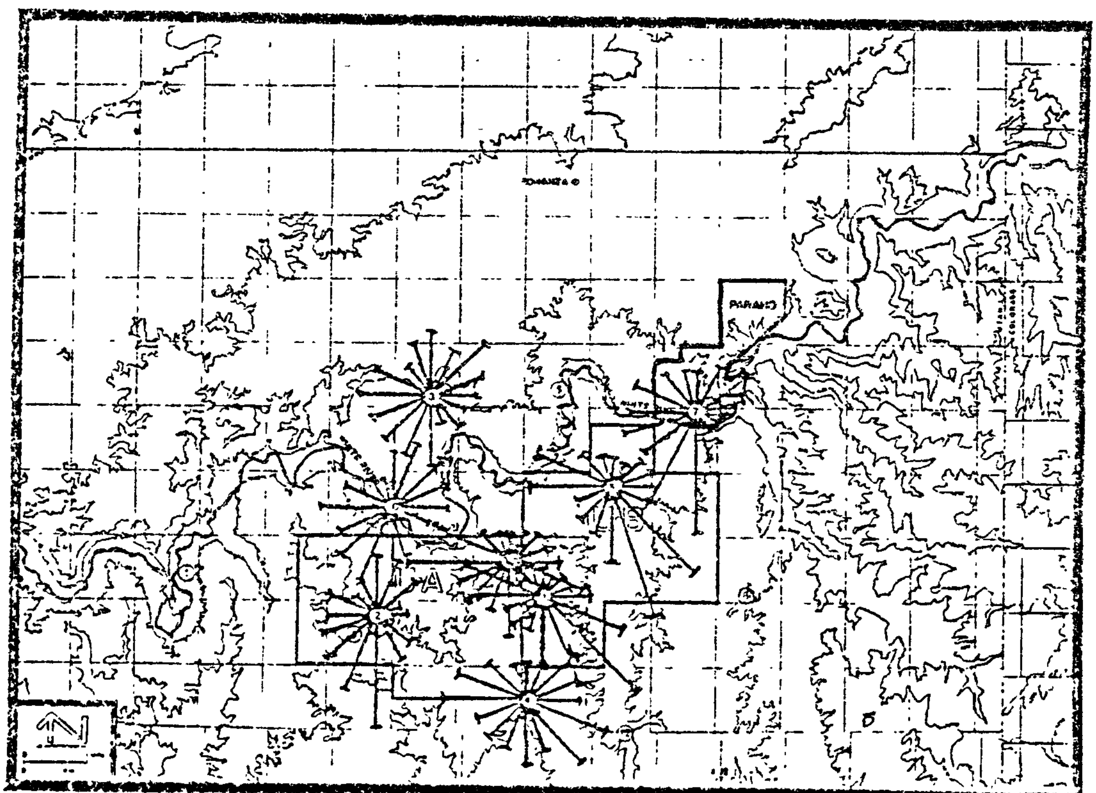


FIGURE 5.1.9 Monthly mean and peak winds speeds at Site A7 during 1975-1976.



0 25%

A. January

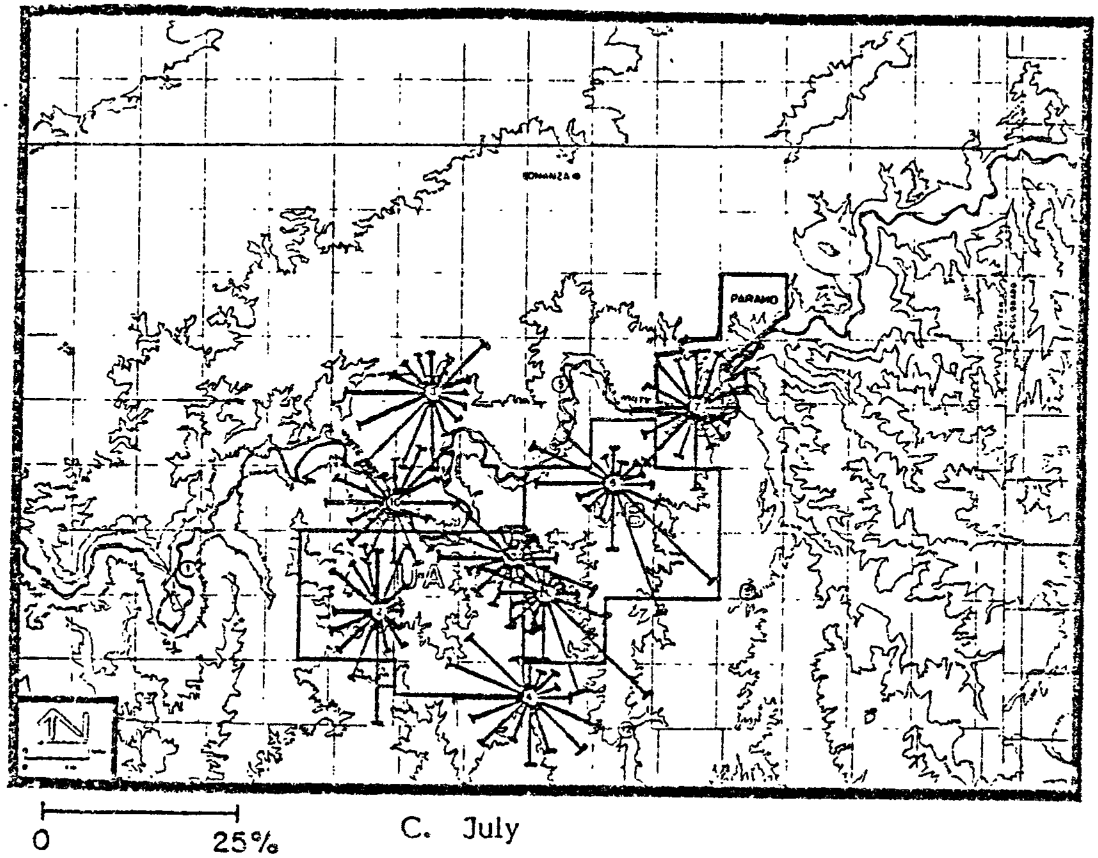


0 25%

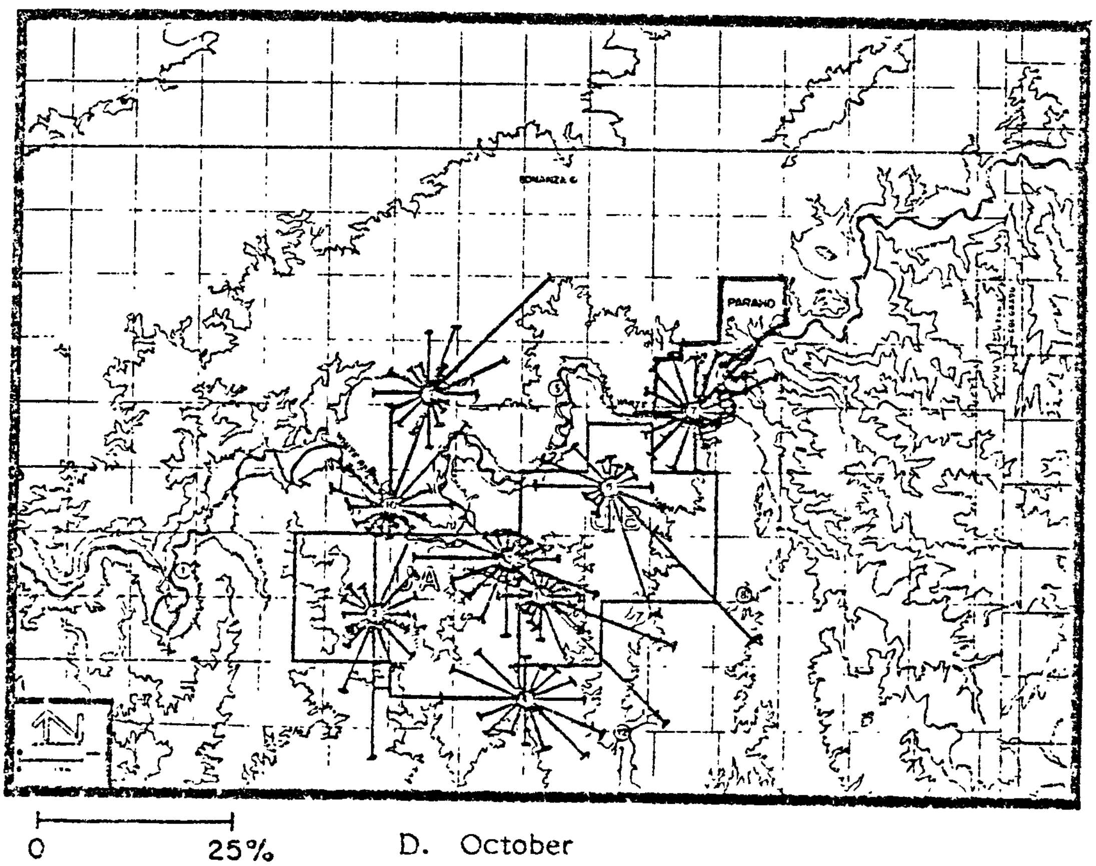
B. April

Figure 5.1.10

DIRECTIONAL WIND ROSES. THE LENGTH OF EACH BAR REPRESENTS THE FREQUENCY OF WINDS FROM THE DIRECTION TOWARD WHICH THE BAR POINTS



C. July



D. October

Figure 5.1.10

(Continued)

a significant percentage of the time at each site, Site A7 best represents surface flow for the Paraho tract.

Upper Air Meteorology. Measurements of the upper air meteorology were made during 1975 on Tract Ub. These measurements included rawinsonde balloon launches twice daily on every sixth day, and continuous acoustic sounding at Site A6. The rawinsonde provided records of temperature, relative humidity, and wind from the surface to the 500 mb (18,000 ft MSL) level. A monostatic acoustic sounder displayed atmospheric structure (mixing height, stability, thermal plumes) up to about a half-mile (one kilometer) above the surface. Additional bistatic records taken less regularly were used to show atmospheric turbulence between 650 ft (200 m) and 1,500 ft (450 m) above ground level.

From January 1975 through January 1976, a surface-based inversion attributable to nocturnal cooling of the earth's surface was observed in the morning 94% of the time, and usually disappeared in the afternoon. The average thickness of the morning inversion was about 1,696 feet (517 m) in winter, 912 feet (278 m) in spring, 1,187 feet (362 m) in summer, and 1,587 feet (484 m) in fall. The strength of the inversion in spring and summer was about 0.8°F per 100 feet (1.5°C/100 m). The strength of the inversion increased in fall and winter with an average of 1.0°F per 100 feet (1.7°C/100 m) and 0.9°F per 100 feet (1.6°C/100 m), respectively.

Upper-air inversions were frequently detected. These inversions were associated with anticyclones that are common in fall and winter, and were indicated in 53 percent of all morning soundings and 87 percent of all afternoon soundings. The average thickness of the morning upper-air inversions was 830 feet (252 m), with an average strength of 0.4°F per 100 feet (0.7°C/100 m). The height of the base of the morning elevated inversions was 540 feet (165 m) above ground level. The average base of the afternoon elevated inversions was higher at about 3,050 feet (930 m). The afternoon inversions had an average thickness of 938 feet (286 m) with an average strength of 0.5°F per 100 feet (0.9°C/100 m). The temperatures measured above the inversions were generally adiabatic and remained almost invariant throughout the day.

The mean mixing heights by season determined from these soundings are listed in Table 5.1.8. The mixing height is defined as the height above the surface through which relatively vigorous vertical mixing occurs. The lowest day-long average mixing heights occur during the winter.

Relative humidity in the lower half-mile (one kilometer) above the ground was about 70 percent in the morning and 65 percent in the afternoon during the winter. There was about a 10 percent decrease in relative humidity during the spring months. The relative humidity continued decreasing to about 50 percent in the morning and to about 35 percent in the afternoon during the summer,

Table 5.1.8

MEAN MIXING HEIGHTS (FEET) NEAR THE PARAHO TRACT DURING 1975

Season	Morning	Afternoon
Winter	233	1,831
Spring	131	3,862
Summer	7	4,101
Fall	161	5,348
Annual	131	3,786

and to about 45 percent in the morning and about 35 percent in the afternoon in the fall.

In the first half-mile above the ground, the winds were quite variable from day to day. Above this first half-mile, winds were usually from the west, with an average speed of about 17.9 mph (8.0 m/s) during the winter and spring quarters and about 8.9 mph (4.0 m/s) in the summer and fall.

Dispersion Characteristics. When a gaseous pollutant in the form of a plume or puff is released into the atmosphere, it is transported by the prevailing wind. As it travels downwind its concentration decreases as the pollutant diffuses into the surrounding air. The growth of the volume occupied by the pollutant is determined by the strength of the turbulence in the air. The strength of the turbulence in the vertical direction is governed mainly by the atmospheric stability, while its strength in the horizontal direction depends upon both stability and on the mechanical generation of turbulence. Mechanical turbulence is defined as irregular airflow induced by surface roughness.

A number of parameters related to diffusivity were measured on the Ua and Ub tracts during 1975-1979. Besides wind speed and direction, these parameters are σ_θ, a measure of the lateral turbulence; σ_w, vertical turbulence fluctuations; and ΔT, the temperature difference between two levels (33 and 100 feet). In addition, special diffusion experiments were performed in February and June 1975 in which smoke plumes were released from 300 feet (90 m), and actual diffusion measured by aircraft probing.

Using σ_θ data at Site A6, the frequency distribution of different diffusion classes has been computed and is given in Table 5.1.9 During each of the years analyzed (1976-1980), diffusion Classes D and E were most prevalent on the tracts.

A complete dispersion picture must also include the effect of plume rise. The meteorological parameters that most greatly influence the height of a plume are atmospheric stability and wind speed. Vertical atmospheric stability can be best defined by ΔT data. Figure 5.1.11 shows the average diurnal variation of ΔT at Site A6 during January and July for 1977-1979. Very stable or slightly stable atmospheric conditions prevailed in early morning and evening hours during January and July, with stability lasting into the late morning in January. In the afternoon, neutral or unstable conditions were a general rule.

The frequency distribution of stabilities during 1977-1979 based on ΔT appears in Table 5.1.10. This table shows that unstable or neutral conditions are the most frequent conditions during all seasons, especially spring. Very stable conditions occurred least often during spring and more often in the fall and winter.

Table 5.1.9

RELATIVE FREQUENCY DISTRIBUTION (%) OF DIFFUSION CLASSES AT SITE A6 FROM 1976 THROUGH 1980, USING σ_θ TO DEFINE THE CLASS

	Diffusion Classes					
	Unstable			Neutral	Slightly Stable	Very Stable
Season	A	B	C	D	E	F
Winter	1.9	4.6	14.9	37.5	35.3	5.8
Spring	4.2	7.4	13.8	38.6	32.8	3.2
Summer	4.5	8.1	19.7	36.5	29.0	2.2
Fall	4.0	8.4	15.7	30.3	34.9	6.7

*Basis: Atomic Energy Commission (1972): Safety guides for water cooled nuclear power plants. NRC Regulatory Guide 1.23.

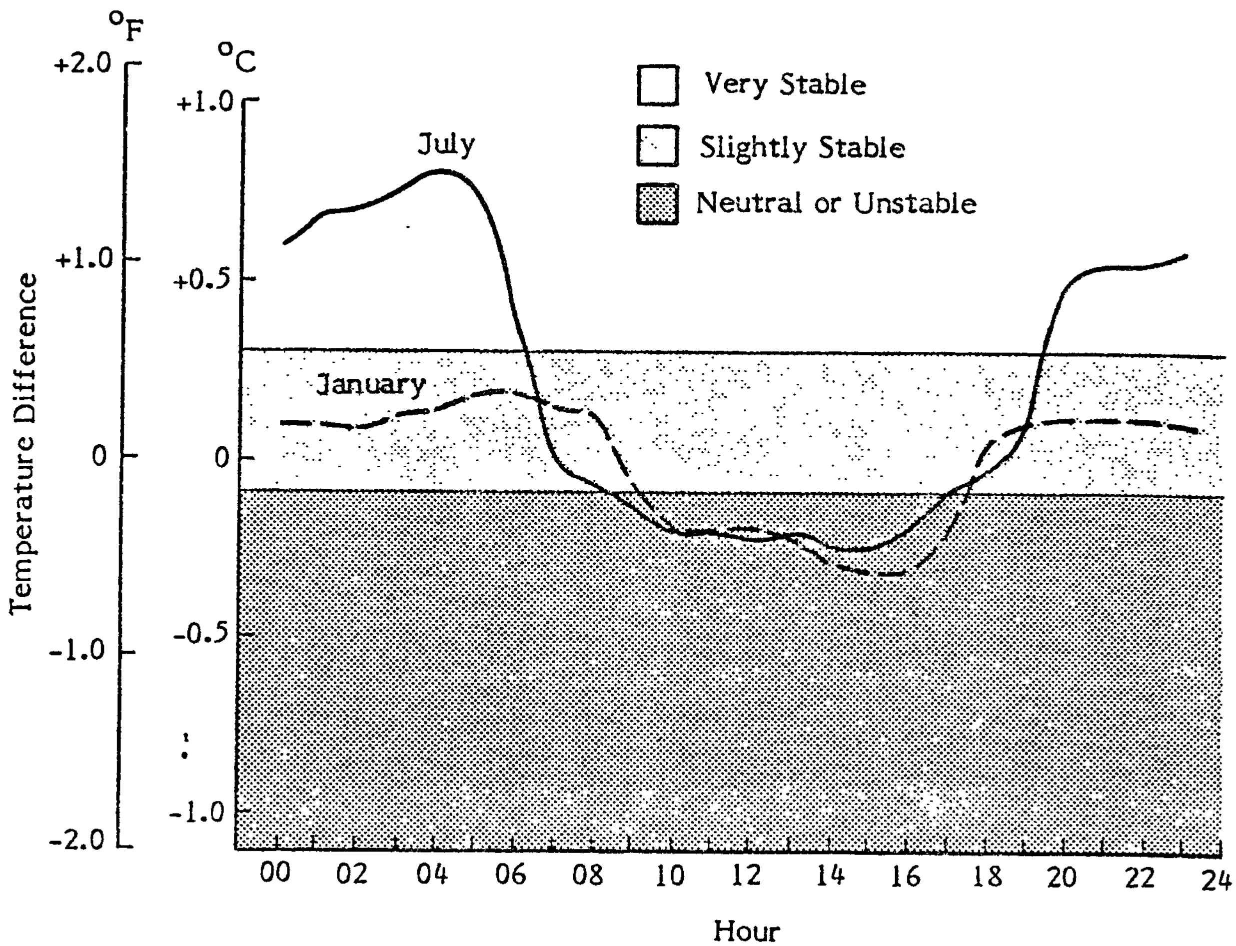


Figure 5.1.11

DIURNAL VARIATION OF THE MEAN ΔT AT SITE A6 IN JANUARY AND JULY FROM 1977 THROUGH 1980.

Table 5.1.10

RELATIVE FREQUENCY DISTRIBUTION (%) OF ΔT (30-10m) AT SITE A6 DURING 1977-1980

Season	Stability		
	Unstable or Neutral	Slightly Stable	Very Stable
Winter	46	19	35
Spring	51	24	25
Summer	40	23	37
Fall	44	17	39
All Year	45	21	34

Air Quality

Factors which reduce the quality of the air include gaseous and particulate air contaminants. Standards, referred to as the National Ambient Air Quality Standards (NAAQS), to protect health have been developed for a number of pollutants. These standards are given in Table 5.1.11. The State of Utah has adopted these standards, so no different state standards exist. Recently a new Federal 1-hour standard for CO of 25 mg/m^3 was proposed and is now in draft stages.

Other values, such as aesthetics, can also be important. The main effect of air contaminants on aesthetics is their impact on visibility. Although Utah has no current standards for visibility, the Environmental Protection Agency (EPA) has promulgated regulations for Visibility Protection for Federal Class I Areas (November 1980). These regulations require the State of Utah to address visibility protection in its State Implementation Plan (SIP).

These topics will be discussed in this section as they relate to concentrations measured in the Ua and Ub tract area. Because of the proximity of the Ua and Ub tracts to the Paraho tract, the remoteness of these tracts from any significant air pollutant emitting source, and the homogeneity of air pollutants in a pristine environment, data collected on the Ua and Ub tracts are representative of the air quality on the Paraho tract. Site A6 is the only site at which air quality has been continuously

Table 5.1.11

NATIONAL AMBIENT AIR QUALITY STANDARDS
(UTAH STANDARDS ARE THE SAME)

Pollutant	Averaging Time	Primary Standards	Secondary Standards
Ozone (O_3)	1-hour *	240 $\mu g/m^3$ (0.12 ppm)	Same as primary
Carbon Monoxide	8-hour *	10 mg/m^3 (9 ppm)	Same as primary
	1-hour *	40 mg/m^3 (35 ppm)	Same as primary
Sulfur Dioxide (SO_2)	annual	80 $\mu g/m^3$ (0.03 ppm)	-
	24-hour *	365 $\mu g/m^3$ (0.14 ppm)	-
	3-hour *	-	1300 $\mu g/m^3$ (0.5 ppm)
Nitrogen Dioxide (NO_2)	annual average	100 $\mu g/m^3$ (0.05 ppm)	Same as primary
Hydrocarbons (corrected for methane - NMHC)	3-hour (6-9 a.m.)	160 $\mu g/m^3$ (0.24 ppm)	Same as primary
Suspended Particulate Matter	annual geometric mean	75 $\mu g/m^3$	60 $\mu g/m^3$
	24-hour *	260 $\mu g/m^3$	150 $\mu g/m^3$
Lead	calendar quarter	1.5 $\mu g/m^3$	Same as primary

* Not to be exceeded more than once per year.

Concentration expressed first in units in which it was promulgated. Equivalent units given in parentheses are based upon a reference temperature of 25°C and a reference pressure of 760 mm of mercury. All measurements of air quality are to be corrected to these references. ppm in this table refers to ppm by volume, or micromoles of pollutant per mole of gas.

monitored since 1975. Therefore, most of the discussions will focus on this site. However, since SO_2 and TSP were measured on the Paraho tract at site A7, this site will also be discussed.

Gaseous Pollutants. The general air quality in the area is discussed briefly here. Gaseous air quality parameters have been measured at Site A6 since late 1974, and include sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), hydrocarbons (HC) and carbon monoxide (CO). SO_2 was also measured at Site A7 during 1975 and 1976. Concentrations for most of these pollutants have generally been very low throughout the area.

The only measured pollutant which exceeded any of the NAAQS was non-methane hydrocarbons (NMHC). However, this standard was developed as a guideline for the control of ozone pollution in urban areas, and not as a health standard. High NMHC values are frequently observed in remote areas, and the high levels in this region are not uncommon.

The only other gaseous pollutant found in significant amounts was ozone. The peaks and averages of ozone at Site A6 during 1975-1980 are given in Table 5.1.12 These values are below the federal standard of 240 ug/m^3.

The monthly average ozone trend at Site A6 over six years is shown in Figure 5.1.12. The highest monthly average of 97 ug/m^3 occurred in February 1979. In general, the highest

Table 5.1.12

HIGHEST, SECOND HIGHEST, AND AVERAGE ONE-HOUR O_3 READINGS ($\mu g/m^3$) FOR SITE A6 DURING 1975-1980 (STANDARD - 240 $\mu g/m^3$)

	1975	1976	1977	1978	1979	1980
Highest	150	140	160	137	151	143
Second Highest	150	140	160	135	149	143
Annual Average	70	63	61	72	73	68

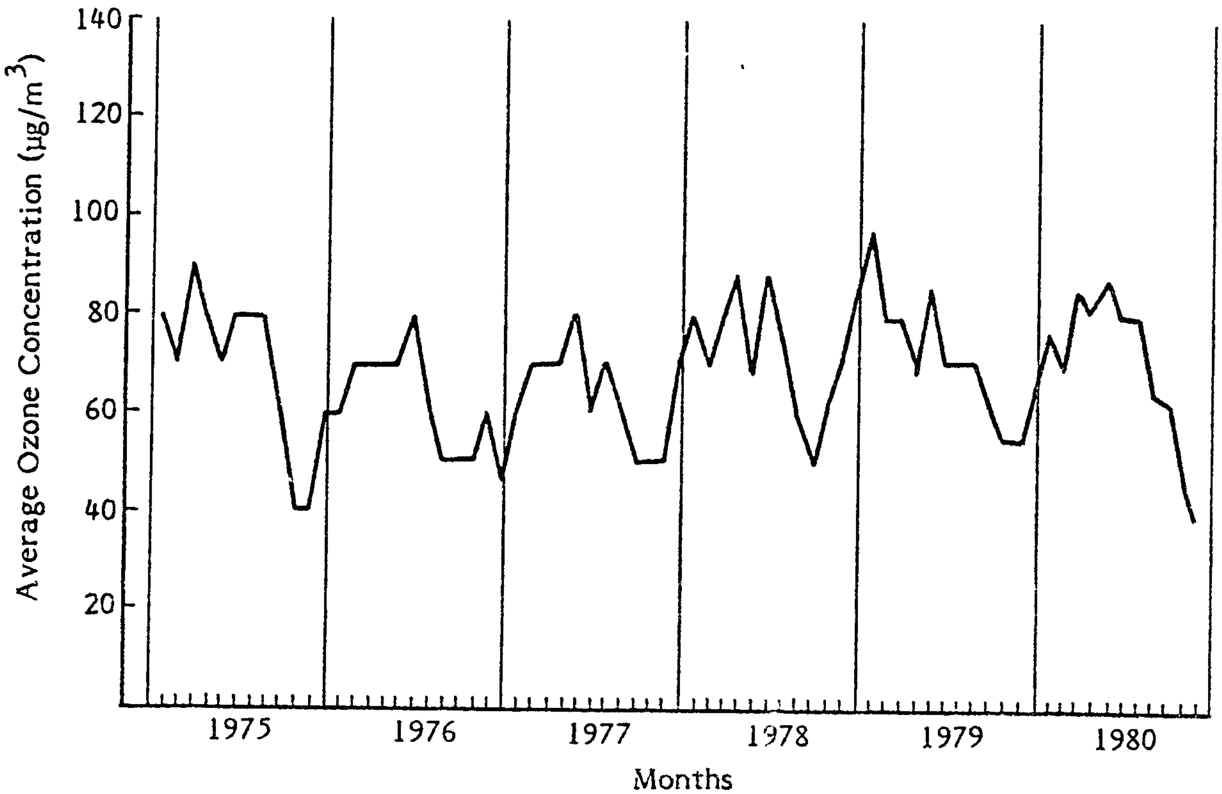


Figure 5.1.12

TREND OF MONTHLY AVERAGE OZONE AT SITE A6 FROM
FEBRUARY 1975 - DECEMBER 1980

ozone values occur during late spring and summer, with occasional high concentrations occurring during the late winter. The ozone concentrations at Site A6 have been found by Chan and Smith (1981) to depend a great deal on the ozone content of the troposphere. Year-to-year variability correlates with the passage of fronts over the site. Unusually high ozone concentrations (>100 ug/m^3) can be attributed to long-range transport from urban areas, strong turbulent atmospheric mixing that brings ozone from aloft to the surface, or ozone intrusion accompanying a frontal passage.

The diurnal varation of ozone during January and July from 1975-1980 is shown in Figure 5.1.13. These curves closely follow the diurnal temperature patterns (Figure 5.1.3) and the inverse of the relative humidity (Figure 5.1.5). This emphasizes the close relationship between sunlight and ozone formation.

Table 5.1.13 presents the highest and second highest one-hour and eight-hour CO concentrations and annual averages in this area from 1975 through 1980. The maximum one-hour reading was 3.0 mg/m^3 in 1975 and the maximum eight-hour reading was 1.8 mg/m^3 in 1976. All CO values were well below the national standards of 40 mg/m^3 (one-hour) and 10 mg/m^3 (eight-hour). When the new 1-hour standard of 25 mg/m^3 goes into effect, CO concentrations should still be well below it.

Of the nitrogen oxides, only NO_2 has a federal ambient air quality standard (annual average of 100 ug/m^3). Table 5.1.14

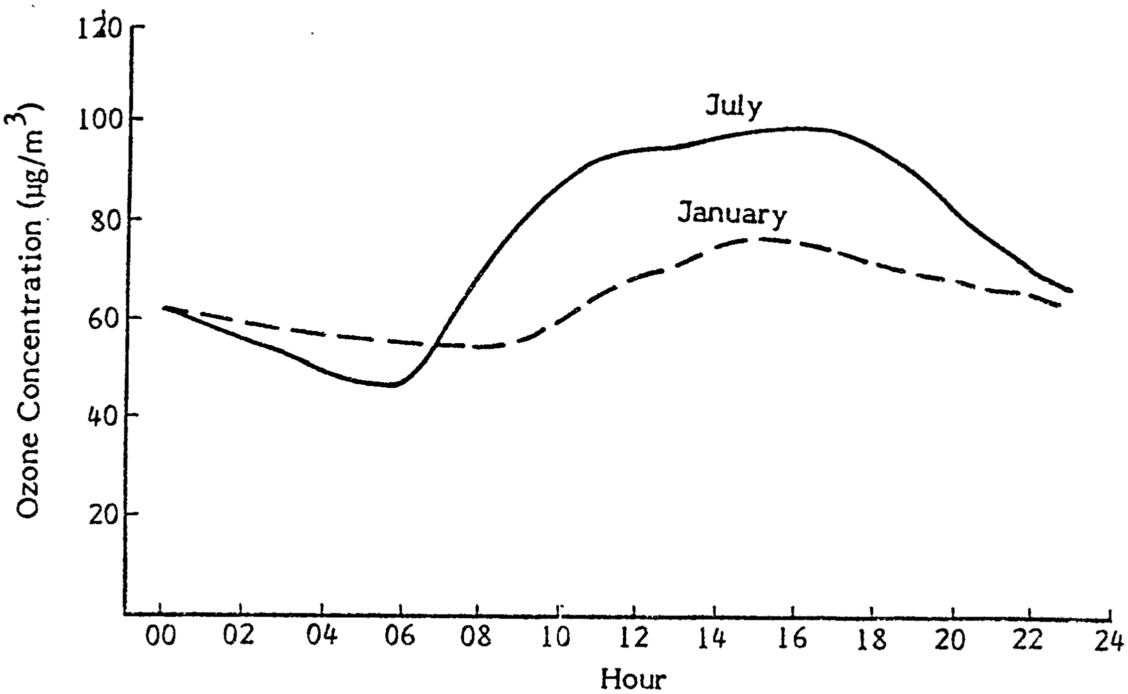


Figure 5.1.13

DIURNAL VARIATION OF MEAN OZONE CONCENTRATIONS AT SITE A6
DURING JANUARY AND JULY 1975 - 1980

Table 5.1.13

HIGHEST, SECOND HIGHEST, AND AVERAGE 1-HOUR AND 3-HOUR CO READING (mg/m^3) FOR THE YEARS 1975-1980 AT SITE A6 (STANDARDS 40 mg/m^3 FOR 1-HOUR AND 10 mg/m^3 FOR 8-HOUR)

		1975	1976	1977	1978	1979	1980
1-hour	Highest	3.0	3.0	1.0	0.7	1.8	2.5
	Second Highest	2.0	2.7	0.9	0.6	0.9	1.9
8-hour	Highest	1.3	1.8	0.6	0.4	0.5	1.5
	Second Highest	0.7	1.7	0.6	0.4	0.5	1.4
Annual Average		0.2	0.1	0.2	0.1	0.1	0.4

Table 5.1.14

HIGHEST AND SECOND HIGHEST 1-HOUR NO_2 READINGS AND ANNUAL AVERAGES ($\mu g/m^3$) FOR THE YEARS 1975-1980 AT SITE A6 (ANNUAL STANDARD = 100 $\mu g/m^3$).

	1975	1976	1977	1978	1979	1980
Highest	100	70	10	15	30	21
Second Highest	80	50	10	13	30	19
Annual Averages	5	5	0	1	1	2

shows the annual averages during monitoring. This table also shows the highest and second highest one-hour averages. Again, these values are very low and do not approach the standard.

Table 5.1.15 gives the highest and second highest three-hour and 24-hour and annual average readings of SO_2 from 1975 through 1980 at Site A6, and 1975 through 1976 at A7. No seasonal or diurnal trend has been evident and most values are less than 10 ug/m^3 (4 ppb). The highest three-hour SO_2 reading of 113 ug/m^3 was recorded at A6 during the fall of 1979. The standard for a three-hour averaging time is 1,300 ug/m^3. The highest 24-hour SO_2 reading was 25 ug/m^3 and was recorded at A7 during 1975. Again, this reading is well below the 24-hour standard of 365 ug/m^3. The annual averages of SO_2 in this area are less than 10 ug/m^3 as compared to the annual standard of 80 ug/m^3.

Particulates. Particulates have been measured for 24 hours every sixth day at Site A6 during 1975 to present and at Site A7 during 1975 and 1976. Table 5.1.16 shows the geometric mean and maxium total particulate concentrations measured at A6 and A7. The highest 24-hour average particulate concentration during these years was 127.0 ug/m^3 in 1980 at A6. The highest annual geometric mean was 19.6 ug/m^3, also at A6 for 1980. These peaks may be due to increased human activity on the tracts in this year. Neither of these values exceeded even the secondary standards for annual (60 ug/m^3) or daily (150 ug/m^3) averaging times.

Table 5.1.15

HIGHEST AND SECOND HIGHEST 3-HOUR AND 24-HOUR AND ANNUAL AVERAGE SO_2 READINGS ($\mu g/m^3$) AT SITES A6 AND A7 (STANDARDS = 3-HOUR, 1300 $\mu g/m^3$; 24-HOUR, 365 $\mu g/m^3$; ANNUAL, 80 $\mu g/m^3$)

		1975	1976	1977	1978	1979	1980
A6							
3-hour	Highest	15	5	15	27	113	16
	Second Highest	15	5	10	25	47	16
24-hour	Highest	10	0	10	14	14	9
	Second Highest	10	0	5	13	6	8
Annual Average		3	0	1	3	0	1
A7							
3-hour	Highest	40	15				
	Second Highest	35	10				
24-hour	Highest	25	10				
	Second Highest	25	10				
Annual Average		7	3				

Table 5.1.16

GEOMETRIC MEANS AND MAXIMUM DAILY AVERAGES FOR PARTICULATES AT SITES A6 AND A7

($\mu g/M^3$)

Site	Season	1975	1976	1977	1978	1979	1980
		Geometric Means					
A6	Winter	-	14.2	13.2	7.2	9.2	9.3
	Spring	17.2	17.2	22.2	14.2	8.1	15.5
	Summer	39.2	34.8	27.6	27.2	19.0	27.9
	Fall	17.2	37.1	22.9	21.3	16.4	37.2
	Annual	24.5	23.5	22.2	15.0	12.5	19.6
		Maximum 24-hour Averages					
	Winter	-	51.9	32.6	13.0	19.6	34.2
	Spring	52.0	45.1	58.3	47.7	34.3	64.6
	Summer	74.7	63.9	47.2	45.2	35.8	41.3
	Fall	52.8	101.2	51.4	62.7	52.9	127.0
		Geometric Means					
A7	Winter	8.2	13.3				
	Spring	10.5	15.8				
	Summer	17.4	15.3				
	Fall	11.1	16.6				
	Annual	11.3	15.2				
		Maximum 24-Hour Averages					
	Winter	13.9	23.7				
	Spring	46.7	77.7				
	Summer	31.6	37.3				
	Fall	26.8	42.1				

The only other criteria pollutant is lead, which was measured on the tracts at Site A2 during 1975 and 1976. The average value for lead during these years was 0.07 ug/m^3. The standard for lead is a maximum quarterly average of 1.5 ug/m^3.

Visibility. Visibility was measured on Tract Ua during 1975 and 1976 using techniques of photography and monitoring light scattering by airborne particles. The latter measurement was at a wavelength of light of approximately 500 nm.

Diurnally, the lowest visibilities (highest scattering) were generally observed during the stable night and early morning hours. During the afternoon, when wind and human activities would tend to increase the dust emissions into the air, better ventilation and mixing tended to counteract any visibility degradation.

Seasonally, the best visibilities were observed during the winter and fall when snow cover suppressed the dust. The lowest scattering (best visibility) observed was $b_s = 0.02 \times 10^{-3} m^{-1}$, which roughly corresponds to a local visual range of 150 miles (235 km). The minimum visual range of 18 miles (29 km) was measured in the spring ($b_s = 0.10 \times 10^{-3} m^{-1}$). The average visual range in 1975 was much lower than in 1976, with averages of 64 miles (103 km) and 81 miles (131 km), respectively. Since very small increases in atmospheric fine particulate matter concentrations have a strong impact on visibility in clean areas, this large difference is probably a consequence of human activity near the monitoring station during 1975. Seasonal visual ranges are given in Table 5.1.17. In general, these readings correspond to very good visibility, with a lack of human-caused haze in the area.

Table 5.1.17

MAXIMUM, MINIMUM, AND AVERAGE LOCAL VISUAL RANGE VALUES
(IN MILES) ON TRACT Ua DURING 1975-1976

	Maximum	Minimum	Average	No. of Observations
Winter	150	29	70	3,778
Spring	150	18	78	3,805
Summer	150	27	65	3,807
Fall	150	31	89	4,345

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5.2 Glossary

Anhydrous -- without water.

Baffled settling -- the settling of particulate matter due to decreased velocity when exhausting air through mined-out chambers.

Baghouse -- a device in which gases are filtered through fabric membranes (bags) to collect particulates.

Barrel (oil) -- 42 U.S. gallons.

Catalyst -- an agent used to speed up or slow down a chemical reaction, and which remains unchanged during the process.

Coalescer -- a vessel used to separate oil from the retort off-gas by condensing the fine oil droplets into larger drops.

Cryogenic -- pertaining to very low temperatures.

Gassy -- refers to mine classification from MSHA regulations 57.21-1, where a mine is classified "gassy" if: (1) the state deems it as "gassy"; or (2) flammable gas has been ignited in the mine; or (3) the concentration of flammable gas is equal to or greater than 0.25% when measured 12" away from any back, face, or rib in any heading; or (4) the mine is connected to a "gassy" mine.

Hydrogen gas reformer -- a process in which natural gas is reformed to produce hydrogen.

Hydrotreating -- a refining process in which hydrogen gas is contacted with the crude oil, which adds hydrogen atoms to the carbon atoms, giving a better grade of crude oil and removes heteroatom impurities such as nitrogen, sulfur, and oxygen.

Hydrotreated shale oil -- shale oil that has been hydrotreated.

Kerogen -- the solid, organic substance in oil shale which yields oil, gas, and coke when the shale undergoes destructive distillation or retorting.

Knockout drum -- a large vessel where some of the oil mist is removed from the retort off-gas by an oil spray.

Low Btu gas -- a gas with a low Btu or heating value.

Off-gas -- the gas that leaves the retort which contains the shale oil as oil mist (see oil mist).

Oil mist -- the mist of condensed oil vapors which are entrained with the off-gas.

On-stream factor -- the operating time divided by the total elapsed time.

Overburden -- soils and geologic material that lay above the mining zone.

Package boiler -- a self-contained steam generating unit of such a size that it can be shipped as a unit from the supplier and installed with a minimum of field labor.

Permeability -- quality of solids which enables them to transmit liquid or gas.

Pour point -- the lowest temperature at which a liquid is able to flow.

Pour point depressant -- an additive that lowers the pour point.

Product gas -- the excess mist-free gas produced in the retort and oil recovery processes which is further treated for removal of nitrogen and sulfur contaminants.

Reclaimer -- a mechanical unit that loads the prepared shale from the storage pile onto a conveyor.

Recycle gas -- the portion of mist-free off-gas returned to the retort.

Retort off-gas -- gases leaving the top of the retort containing an entrained mist of crude shale oil.

Rip-rap facing -- a means of protecting an embankment wall from erosion using a covering of large rocks.

Roof bolting -- a system of mine roof support where bolts are inserted in the roof strata to form a composite stronger than the individual strata.

Room-and-pillar -- an underground mining pattern referring to rooms of mined material used for production and pillars of unmined material that are left for overburden support.

Scaling -- the removal of loose rock from the back (roof) and ribs (walls) of a mine.

Sour water -- water which contains hydrogen sulfide and ammonia.

Stream day -- refers to on-stream factor. On-stream factor is the percent of total time (24 hours/day) that facilities will be in production which is assumed to be 90% for this project. Thus, there are 330 stream days in a calendar year. The remaining 10%, 35 days/calendar year, will be time needed for maintenance of component facilities.

Stretford unit -- a patented system using regenerative oxidation-reduction reactors to reduce hydrogen sulfide in gas streams to elemental sulfur.

Tank farm -- the area, surrounded by an embankment, that contains large storage tanks for the crude and hydrotreated shale oils.

Water wash -- the use of water to remove the soluble constituents from a gas stream.

Wet scrubber -- a device used to remove particulate matter from a gas by passing the gas stream through water pools or sprays.

Wet suppression -- an operation used to suppress particulate emissions by spraying or wetting the surface with water.